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[THIRD SERIES.]

ART. LIV.—*Note on the Duplicity of the "1474" line in the Solar Spectrum;* by Professor C. A. YOUNG.

THE line "1474" is the one which is reversed in the spectrum of the Solar Corona, and coincides with one of the short lines in the spectrum of iron. In the iron spectrum it is brought out, however, only by the Leyden jar spark, and not by the electric arc between carbon points. As seen in the solar spectrum, with ordinary, or even very powerful, spectroscopes, it appears like a fine, hard, black line.

In examining this portion of the spectrum recently with a diffraction spectroscope, armed with a silvered glass "gitterplatte" of 8640 lines to the inch, for which I am indebted to the kindness of Mr. Rutherfurd, I find this line to be unmistakably double; the two components are separated by a distance of only about $\frac{1}{4}$ of a division of Ångstrom's scale, i. e. about $\frac{1}{40}$ of the distance of the D lines. The more refrangible component is heavier than the other and slightly winged or hazy at the edges, while the other is narrower and better defined. The more refrangible line is undoubtedly the real corona line, and the other belongs to the spectrum of iron, the close coincidence being merely accidental.

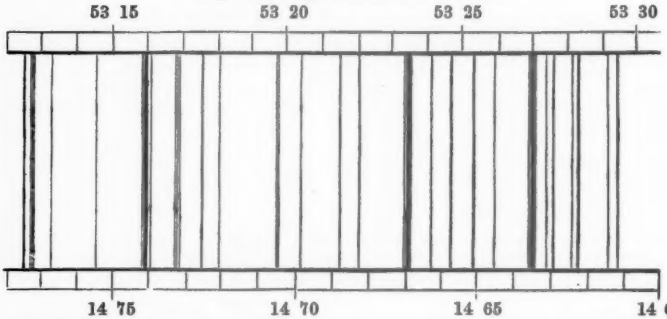
As long ago as 1870 I suspected the bright 1474, as seen on the limb of the sun, to be very slightly more refrangible than its dark analogue (the position of which with insufficient dispersive power would apparently correspond to the *mean* of the two components); and the suspicion has recurred from time to time on many occasions since then, while there has not been a single instance in which the bright line appeared to fall *below*

the dark one. Still there has never seemed to be sufficient evidence to warrant a positive assertion. Examination with a speculum metal "gitterplatte" of 6480 lines to the inch, some two years ago, suggested the idea that the dark line might be closely double, but the definition of the grating was not sufficiently good to decide the question. With the new one, however, there remains no doubt. Another grating with 17280 lines to the inch, which is temporarily in my possession, shows it nearly, though not quite as well.

The accompanying map of this region of the spectrum gives a good idea of the appearance of things, and the amount of dispersive power obtained. The scale numbers at the top are those of Ångstrom, those at the bottom are Kirchoff's.

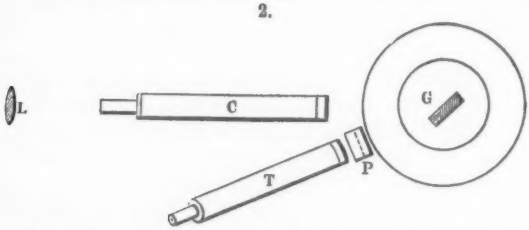
1.

Map of the region of the Corona-line.



The observations are best made in the spectrum of the 8th order (with the coarser grating—in the spectrum of the 5th order with the grating of 17280 lines to the inch) although the duplicity of the line is clearly visible in the spectra of the 6th, 7th, and 9th order, with proper precautions. The arrangement employed is that indicated in fig. 2. C is the collimator, the

2.



beam of light, thrown into the room by a heliostat, being concentrated by the lens L which forms an image of the sun on the

slit. G is the "gitterplatte." P is a prism of 45°, with its refracting edge horizontal, and so placed as to bend upward the pencil of rays from G. T is the observing telescope, with the eye end elevated at an angle of about 35° so as to receive the rays from G after they pass the prism.

The spectra of the higher orders so overlap, that without the prism, or some analogous contrivance, it is impossible to observe in them any but a few of the strongest lines. By the prism these spectra are separated, one lying above the other; the red of the 6th order, for instance, falling below the yellow of the 7th, and this underneath the green of the 8th, while above this green lies the blue of the 9th order, and above that the extreme violet of the 10th. Thus the different spectra no longer interfere, and it is just as easy to observe the spectrum of the 8th order as that of the 1st, except that the former is fainter on account of the greater dispersion, and the obliquity of the grating, which narrows the transmitted pencil. A direct-vision prism in the eye-piece of the telescope answers the same purpose, but less perfectly. The same plan may have been used before. If so, however, I am not aware of it.

Hanover, N. H., April 19, 1876.

ART. LV.—*Contributions from the Sheffield Laboratory of Yale College.* No. XL.—*On a Lithia-bearing variety of Biotite;* by GEORGE W. HAWES.

THE feldspar quarries about Portland and Middletown in Connecticut have furnished many interesting minerals. The quarries are in the large granitic veins which intersect the gneiss and mica schist of the region. These veins, which have been described by various authors, are remarkable for the similarity of their mineral constituents, and the presence in several of rare elements, and it will be shown in this article that a lithia-bearing biotite is generally present. The feldspar is of two kinds, orthoclase and albite; considerable quartz is found, and with the feldspar it often forms beautiful specimens of graphic granite. Tourmaline, beryl, garnet, columbite, muscovite and biotite are common, and other species are found more rarely. Plates of muscovite and biotite united by their edges are of frequent occurrence, and sometimes one forms the center of a large crystal or plate of the other. The cleavage lines which are developed by striking the thin plates with a sharp point show that when the two species are thus united, there is a simple relationship between the axes of the muscovite and biotite, as long since found by Prof. G. Rose to be a general fact in the

case of such combined crystals of mica. Some of the specimens examined by Rose came from granitic veins similar to those of Portland and Middletown. The cleavage lines begun in one mica often run some distance into the other without a change of direction, proving the complete continuity of the two.

The biotite of Portland is black, and possesses a high luster. In thin plates it is transparent, clear, and brown by transmitted light. It is optically uniaxial. Specific gravity 2·96. When heated before the blowpipe it imparts to the flame the characteristic carmine-red color of lithia, and it appears thus to differ from all the described varieties of the species. It afforded me, on analysis, the following results:

	I.	II.	Mean.
Silica	35·59	35·62	35·61
Alumina	19·99	20·08	20·03
Ferric oxide	·15	·11	·13
Ferrous oxide	21·83	21·86	21·85
Manganous oxide	1·19	1·18	1·19
Magnesia	5·26	5·20	5·23
Potash	9·61	9·76	9·69
Soda	·49	·55	·52
Lithia	·96	·94	·93
Titanic acid	1·45	1·47	1·46
Fluorine	·76	·76	·76
Chlorine	*tr.*	*tr.*	*tr.*
Water	1·84	1·90	1·87
	99·12	99·43	99·27

The ratio of the R : R : Si is 1 : 1 : 2; and the analysis hence shows that the mica is an *iron* biotite, which has lithia replacing part of the potash, and which contains much more ferrous oxide and less magnesia than is common. It fuses before the blowpipe to a magnetic globule. Some specimens fuse with greater difficulty and give little color to the flame, indicating a transition toward the more ordinary variety. I would call attention to the fact that the iron of this mica oxidizes with great readiness both when heated and when exposed to the weather, and this shows how easy it would be to derive lepidomelane from it by alteration. This lithia-biotite seems to be widely distributed in granitic veins. Specimens from similar granitic veins in New Hampshire, Massachusetts and North Carolina were examined which imparted more or less of the lithia coloration to the flame, fused to magnetic globules, and which possessed the same physical appearance and the same association as the Portland biotite.

ART. LVI.—*Researches on the Solid Carbon Compounds in Meteorites;* by J. LAWRENCE SMITH, Louisville, Ky.

[Concluded from page 395.]

Action of strong nitric acid on the graphite.—Strong nitric acid, poured upon the powdered graphite that had been treated with ether and bi-sulphide of carbon acted vigorously upon the sulphide of iron mixed with it, and after digestion for some time in the acid and washing thoroughly with water, there remained 55 p. c. of the original matter, which consisted of carbon. This burnt in air with great difficulty, but very easily in oxygen, leaving a residue of one per cent of ash.

The nitric acid solution was analyzed and found to contain

Sulphur	35·05	Troilite.
Iron	62·21	
Cobalt	0·56	
Nickel	0·16	
Magnesia	0·30	
Silica	0·21	
	98·52	

It is a fact of some interest that in the sulphide of iron which occurs in meteoric irons (when these nodules are perfectly free from any adhering iron) the quantity of nickel and cobalt present is very minute, a most singular fact if we are to regard these nodules as the result of segregations from the mass of iron. And still further, while the nickel is very largly the predominant metal of the two in the iron, I have noted that the cobalt predominates over the nickel in the sulphide nodules; but I would not without further examination regard this as likely to be the rule in all cases.

Action of fuming nitric acid mixed with potash chlorate on the meteoric graphite.—The oxidation of graphite by this method is well known to chemists, it having been first pointed out, as I have stated, by Mr. Brodie in 1860, and subsequently by Berthelot in his elaborate memoirs published in the *Annales de Chemie et de Physique*, 4th series, volumes xix and xxx. The result is the formation of a substance which Brodie called graphitic acid and Berthelot graphitic oxide, although the compound invariably contains hydrogen as an essential element in its constitution. M. Berthelot made use of this reaction to study the different forms of carbon, finding that the results of the oxidation varied with the carbon from different sources, only those forms of carbon known as graphites proper furnishing the graphitic oxide. The same chemist studied this oxid-

izing action upon the graphite from the Cranbourne meteoric iron, and also upon the carbon from the Orgueil meteorite, and found that, of the two, only the graphite from the meteoric iron gave rise to the oxide.

The study of this subject I have pushed further, and have oxidized the graphites from the Sevier County and the De Kalb County meteorites, and have also re-examined that of the Cranbourne iron—having been very liberally furnished with a specimen by my friend, Prof. Maskelyne, of the British Museum. The carbonaceous matter from the Orgueil meteorite has also been subjected by me to the same reaction.

The details of conducting the process were identically those proposed by M. Berthelot in the memoirs already referred to, viz: To free the powdered graphite from sulphide of iron by first treating it with strong nitric acid, washing it thoroughly on a filter, drying it and mixing it with five times its weight of potash chlorate, then adding this mixture little by little to sufficient fuming nitric acid to moisten thoroughly the mass. In making the mixture, I place the nitric acid in a capsule and the latter in a little water with a piece of ice, thus avoiding any risk of explosion. The mixture, after standing a few hours is transferred to a ballon d'assais, and gently heated in a water bath at a temperature from 50° to 60° C. for several days. The result of this action upon the graphites of the Sevier County and DeKalb County meteoric irons was the formation of graphitic oxide, with all the characteristics of that furnished to Berthelot by the graphite from the Cranbourne iron, as well as to myself from this last graphite.

The conversion of the meteoric graphite into the oxide is more rapid than that of any terrestrial graphite with which I have experimented. The graphite soon changes from black to green, and finally, after two or three applications of the oxidizing agent, to a perfectly white substance. This, when filtered, washed, and dried under a bell glass with sulphuric acid, gives a yellow powder, somewhat adherent. If the oxidizing action of the nitric acid and potash chlorate be renewed several times on the same material, the oxide gradually diminishes in quantity, and if the process be stopped after the fourth or fifth treatment, the oxide is very gummy, adhering to the filter and preventing complete washing. When dried on the filter it adheres firmly, but can be detached by moistening the filter and rubbing off the paper with the finger, leaving tenacious flaky films.

The reaction and decomposition of the oxide obtained from the Sevier graphite is the same as that of the oxide from other sources.

My experiments on terrestrial graphites have been confined

to the Siberian, Cumberland, and Ceylon varieties; and they show that the graphite under consideration differs from them in being more readily converted into oxide, it requiring only one-fifth to one-third of the time; and if the operation be continued by frequently renewing the oxidizing agents, the oxide first formed gradually diminishes in quantity, being more thoroughly altered, like some of those forms of carbon ranked as not properly graphites.

In fact, it appears that the meteoric graphites, when tested by this process, occupy a place between graphites proper and ordinary carbon, but much nearer to the graphites.

After completing my examination of the carbon nodules of the irons, my aim was to see what general deductions could be made with reference to the relations this graphitic material bore to the carbon found in the black meteoric stones. The material to operate with is, however, very rare; but I had in my collection enough for all necessary comparisons, though needing much more in order to obtain the peculiar products in sufficient quantities for chemical analysis.

The Alais meteorite.

Two grams of this meteorite were pulverized finely and treated with boiling water, which dissolved out a small amount of matter; which substance has been studied by others and it is not my object to recur to here.

The powder was then dried and treated with pure ether, in the same manner as the graphite from the Sevier iron, and the ether allowed to evaporate slowly at a moderate temperature, when the sides of the vessel became covered with acicular crystals, mixed with a few rhomboidal crystals. The residue had a peculiar odor, similar to that of the ether extract from the graphite of the Sevier iron, which odor it nearly lost in the same way, after several days exposure to the air. The form and appearance of the crystals are the same as of those obtained from that graphite; and a portion of the crystals detached and heated in a small tube gave the same character or reaction.

These crystals have already been studied by Prof. Roscoe, of Manchester, as carefully as could be done with the minute quantity at his disposal. My examination is perfectly in accordance with his, and there is no doubt that this product and that from the graphite must be of the same nature.

We must not forget to mention that Prof. Wöhler was the first to call attention to the hydrocarbon in these black meteorites when examining the one which fell at Kaba.

Orgueil meteorite.

This meteorite is one of the most interesting of all the known carbonaceous meteorites. And there are one or

two points connected with it that do not appropriately belong to this paper, of which I will furnish a note before long. Through the liberality of Prof. Daubrée, and the Administration of the Garden of Plants, I have been furnished with the material on which my investigations have been made. This meteorite has, in most respects, been thoroughly examined by M. Cloez, and by M. Pisani, and their results given in the Comptes Rendus for 1864. The former chemist examined the carbonaceous matter as a whole, considering it to resemble humus; and this on drying at 110° gave him: Carbon 63·45, hydrogen 5·98, oxygen 30·75.

I have, as yet, done little toward the re-examination of this substance, which represents from four to six per cent of the entire meteorite, my examinations being made principally for those crystalline products, soluble in ether and bisulphide of carbon, of which I have found about one-half per cent in the meteorite.

The powdered meteorite was first treated with water and heated over a water-bath, and every thing soluble in that menstruum thoroughly washed out. The soluble portion, dried at 100° C., represents 8·65 per cent of the mass. After carefully drying the insoluble portion at 100° C., it was treated with ether in the same manner as the meteoric graphite. The ether was used in large excess, and allowed to remain for ten or twelve hours in contact with the material; the ether was filtered off, and the residue on the filter well washed with ether. The etherial solution was evaporated slowly, when the same acicular crystals made their appearance as in the case of the graphite, and numerous rhomboidal crystals were deposited in the bottom of the beaker. These appeared to be identical with those from the graphite. The action of heat on these crystals is the same as on those from the Sevier graphite.

The powdered meteorite exhausted by the water and ether was next treated by the bisulphide of carbon, when an additional quantity of soluble matter was obtained. On evaporating the bisulphide of carbon, a yellow mass remained having the aspect of sulphur. This, when heated, gave evidence of being sulphur mixed with some carbon compound. And to all appearance it was just like the substance obtained by similar treatment of the meteoric graphite.

The crystals in the upper part of the vessel from which the ether was evaporated being detached by scraping the sides of the vessel with a horn spatula, some bisulphide of carbon was poured upon the portions remaining attached to the vessel by which it was dissolved. The bisulphide of carbon was subsequently evaporated, when a residue was left consisting of a yellow solid surrounded by a dark brown semi-solid mass in

minute quantity. This last is evidently a carbon combination not contaminated with sulphur, while the yellow mass is sulphur containing a small portion of the carbon compound.

I was enabled to obtain over 400 milligrams of these mixtures from about 50 grams of the meteorite, much the larger portion being sulphur. A few attempts were made to separate the sulphur from the carbon compound, but unsuccessfully; and I soon saw that by continuing my efforts, I should exhaust the small supply of material without reaching any useful result. So it was thought better to save what was left of the material as a specimen of it.

The other carbon meteorites I have not yet examined with regard to the points embraced in this report, but I hope to obtain sufficient material before long to allow of this being done, though I do not anticipate any different results from those that have been examined.

The nature of the hydrocarbon found in the meteoric graphite and carbonaceous meteorites.

That this substance belongs to the meteorites at the time of their fall, there can be no doubt; for in the carbonaceous meteorites there is nothing to enable us to account for its formation in the cabinets in which they have been placed after their fall. And in the case of the graphite nodules they were encased in the interior of an iron mass over twenty centimeters in diameter; and, furthermore, the powder operated with was taken from the interior of a compact nodule of graphite.

I have been strongly inclined to consider this as a hydrocarbon containing combined sulphur forming a sulph-hydrocarbon. In the absence of chemical evidence sustaining this view, I lay some stress on the peculiar odor of the ether extract, strengthened by a most singular property of the watery extract from the Orgueil meteorite, of which I will make a short statement, reserving for some future occasion any additional remarks.

If a small quantity of the powdered Orgueil meteorite, say two grams, be treated with water and heated for a short time over a water-bath, no peculiar odor will be observed, however carefully examined. Throw this on a filter and wash with water, then evaporate the filtrate to dryness over a water-bath, and during this time no odor will be observed. Allow the residue to cool, and still there is no odor. But now throw upon the residue a little water, say half to one cubic centimeter, move the capsule around to dissolve the mass, and then on bringing it near to the nose, a marked alliaceous odor will be perceived, sometimes so strong as to be disagreeable, reminding one of the odor of the oil of assafœtida. That it is produced

by a sulphur compound chemists will be apt to admit, perhaps a minute quantity of sulphur compound not unlike the sulphhydrate of ethylene $C^4H^6S^4$; and the needle-shaped crystals may not be far removed from the solid quintisulphide of ethylene, $C^4H^6S^5$, corresponding to sulphur 75·00, carbon 20·00, hydrogen 5·00. The crystals I scraped from the sides of the beaker—at the upper part—on which the ether solution of the Orgueil meteorite was evaporated to dryness, gave—sulphur 79·65, carbon 15·00, hydrogen 3·00.

In the above analysis the amount of sulphur is well determined; but the examination for carbon and hydrogen was made upon so small a quantity, that the results cannot be relied upon as very correct.

Roscoe burnt in dry oxygen ·008 grams of the residue from the Alais meteorite, and obtained ·010 grams of sulphurous acid, ·008 grams of carbonic acid, and ·003 grams of water, making sulphur 125 parts, carbon 54 parts, hydrogen 10.

As the above analysis was made with only eight milligrams, of course the results can be considered only as an approximation; but nevertheless, until we get better they must serve as our only guides.

I have not said anything about the gaseous carbon compounds found in meteorites, as these form a separate study from what is designed in this paper, and besides, Profs. Graham, Mallet, Wright, and others have already investigated their nature. Profs. Wright and Mallet are still engaged in this line of investigation.

Conclusions.

These then are some of the results of my experiments on the carbon of meteorites, and they are of great interest and importance. That we should find in the graphitic concretions from the interior of a solid mass of iron such substances as free sulphur and a hydrocarbon, simple, or combined with sulphur, having a marked odor, was certainly not to be expected, especially as we are almost forced to believe that the iron containing it must have been at some period in a state of fusion.*

The graphite nodules themselves are grand chemical and physical puzzles, as well as all the nodular concretions in meteoric irons; that they have resulted from a process of segregation is self-evident, but how marvelous the completeness of this segregation, for if we analyze the iron even within two or three millimeters of the concretions, only traces of the charac-

* In an article recently published by Dr. Mohr (Annalen der Chem. und Pharm., Dec. 1875, page 257), he advances the theory that meteoric iron and meteoric stones have been formed by the agency of water; his arguments are interesting, but far from being sufficient to cover all the facts in connection with meteorites.

teristic constituents of the nodules are here found. Then again, in the case of the troilite concretions, this sulphide has been separated from the mass of iron, and a phosphide of iron and nickel has been concreting along with it; and yet, there seems to be so great an incompatibility between these two minerals that they could not commingle, but the phosphuret was thrust, as it were, to the exterior of the nodule, there to form a thin covering to the sulphide, like the skin of an orange over the internal pulp.

Again, the graphitic concretions bear no resemblance to the scaly graphite found in the slag of iron furnaces and between the crystals of cast iron, either in structure or appearance; the fractured surface is more like that of the Borrowdale graphite, but the oxidizing action of the nitric acid and potash chlorate on this last differs somewhat from the action on the meteoric graphite. Many and varied have been the hypotheses formed in my mind to account for the formation and accumulation of this graphite, but I must admit that I have been forced at last to abandon them all, as none covers all the facts of the case. In appearance this graphite is more like the amorphous carbon that is separated from cast iron, but the oxidizing action of nitric acid and chlorate of potash at once points out their great difference as shown by Berthelot's experiments.* And although it differs in appearance from the scaly graphite of iron, the oxidation of the two are very similar. I am more inclined to adopt the suggestion of Berthelot, that it may be formed by the reaction of bisulphide of carbon upon incandescent iron, as this reaction is known to give rise to an amorphous graphite analogous to the one under consideration, and its association with sulphide of iron would lend some support to this hypothesis; and still further the presence of free sulphur and a carbon compound, either a hydrocarbon, or sulph-hydrocarbon, points also in that direction for a solution.

It is very clear from the present accumulated knowledge of the geological occurrences of graphite that we must abandon all attempt to account for its formation by any one series of reactions on the interior of our globe; for it is to be found in basaltic rocks, in the older crystalline rocks, and through all the series of rocks up to the recent Tertiary formations; and when we add to this the laboratory experiments of Berthelot that I have so frequently quoted, this view of the subject is strengthened. But on this point I may have something more to say in a paper on the Ovifak iron, and the graphite in the basalt in which this iron is found.

The carbon from the black meteorites, as the Orgueil, Alais, etc., I consider as having a similar origin to that found in the

* Annales de Chem. et de Physique, Fourth Series, xix, 425.

irons; for I have proved that they both contain similar crystalline products soluble in ether and sulphide of carbon, and while the carbonaceous matter reacts differently when treated with nitric acid and potash chlorate, this may arise from the difference of conditions under which the reaction took place that gave rise to it.

That the carbonaceous matter in the black meteorites is to be regarded as a kind of humus arising from organized matter is contrary to all we know about humus. For if we examine the mineral constituents of these meteorites, we find them to be a granular mass, with particles more or less impalpable, composed essentially of olivine and pyroxene, a most unpromising soil for so luxuriant a growth of vegetation as must have occurred to produce so abundant a percentage of carbonaceous matter as that found in the Orgueil meteorite. The action of caustic potash upon it is different from the action of that alkali upon what is commonly called humus; (although we must bear in mind that humus is not a well-defined substance; it being commonly regarded as vegetable matter that has not undergone complete decomposition into water and carbon, but by imperfect oxidation was converted into a varied mixture of carbon and certain organic compounds rich in carbon, some of them soluble in caustic alkalies). After the powdered Orgueil meteorite has been exhausted by water, ether, and sulphide of carbon, caustic potash or soda dissolves but an exceedingly minute trace of the carbonaceous matter, and even that trace may be a little hydrocarbon not extracted from the mass by the ether and sulphide of carbon. If a portion of the same be dried at 110° C., and then heated in a closed tube, water will not be given off until the temperature is elevated considerably. If the temperature be further increased, only a very slight odor is apparent; and this is another marked difference between it and humus. If heated on platinum foil, the carbonaceous matter burns off very readily with little or no odor, leaving an abundant residue. According to my experiments this combustible matter amounts to about 4·5 per cent of the entire meteorite.

It is not at all improbable that the carbonaceous matter of the black meteorites approaches in character the so-called hydrated carbon first pointed out by M. Eggert, but so clearly defined by MM. Schutzenberger and Bourgeois in a communication made to the Chemical Society of Paris in April, 1875, which was obtained from white cast iron by dissolving away the iron. But it is a question in my mind whether the carbon combination thus obtained from white iron is to be properly considered a hydrated carbon; that is to say, whether we are to consider the H^2O as united to the carbon in the same way as it is to metallic oxides to form what are known as hydrated

oxides. If, however, it is to be considered as combined in a manner analogous to the H^2O, with ethyl to form alcohol, then there may be some plausibility in the hypothesis. For it will be remarked in referring to the actions of this hydrated carbon that it in no way resembles amorphous or ordinary carbon.

It is represented by MM. Schutzenberger and Bourgeois as follows: $C^{11}:3H^2O$=carbon 70·95, hydrogen 3·23, oxygen 25·80 per cent.

According to M. Cloez, the carbonaceous matter of the Orgueil meteorite, after being dried at 110°, was found to be composed of carbon 63·45, hydrogen 5·98, oxygen 30·75; and when we consider that some of this hydrogen belongs to the hydrocarbon now known to exist in that meteorite, the remainder of the hydrogen will approach near the proportion required to form water with the oxygen; and the quantity of carbon that may exist as a hydrate will be slightly diminished.

Attempts were made to separate completely all the mineral matter from the carbon, but I have failed to do so, after using fluorhydric acid alone, and in conjunction with nitric acid, also fluoride of sodium and sulphuric acid with a small amount of water, then treating the residue with cold nitric acid. There is no difficulty in getting rid of a great part of it, but in every instance the carbonaceous matter has been altered, however carefully the temperature was managed.

When this matter thus obtained is heated in a closed tube, after being dried at 110° C., it not only furnishes water at about 250° C., but gives out a very strong odor somewhat like that produced from certain bituminous coals, at one point resembling the disagreeable odor of an ignited cigar of a very inferior quality of tobacco.*

Viewed in the light of these experimental researches, the most reasonable conclusion is that this carbonaceous matter is not in any proper sense either carbon or humus, but a carbon compound analogous to the one just referred to.

Future researches upon these solid compounds, resembling in appearance amorphous carbon, such as hydrographitic oxide, pyrographitic oxide, carbon-hydrate, and similar compounds that may yet be discovered, will doubtless throw some light on the true nature of the carbonaceous compound of the black meteorites. So far as our knowledge now extends, its formation and its origin are wrapped in as much obscurity as the origin of the bodies in which it is found.

What we do know is that this carbonaceous matter occurs with the same minerals, viz., olivine and pyroxene, which are the predominating constituent materials of all stony meteorites;

* This odor will be found to belong to the hydrated carbon from cast iron, when heated in the same way.

also with the nickeliferous iron found in both the stoney and metallic meteorites; and furthermore, that this carbonaceous matter contains curious crystalline products soluble in ether and sulphide of carbon, which last have been traced in the graphite nodules in the interior of the metallic meteorites. Moreover in these graphite nodules we have found magnesia, which is so uniformly a constituent of the minerals of the stoney meteorites.

So far then as our present knowledge goes, we know of celestial carbon in three conditions, viz: in the *gaseous form* as detected by the spectroscope in the attenuated matter of comets; in meteorites in the *solid form*, impalpable in its nature and diffused in small quantities through pulverulent masses of mineral matter that come to the earth from celestial regions; also in the *solid form, but compact and hard*, resembling terrestrial graphite, and this is imbedded in metallic matter that comes from regions in space. But while we speak of these as forms of carbon, I think we should be careful in associating it in our minds with the element carbon as we understand it in its pure state whether crystallized or amorphous, for I cannot reconcile the carbon vapor detected in comets as simply that known as pure carbon in the form of an elastic vapor, nor are we to circumscribe ourselves with the notion that this cosmical carbon has an organic origin.

The researches embraced in this communication, while in many respects of a novel character, are imperfect from their very nature, both from lack of material for a thorough and complete study, as well as from the present imperfect methods of operating upon a minute quantity of the most interesting of the substances obtained.

I have therefore detailed as carefully as I could all the results as they have developed themselves, hoping that future opportunities may be afforded for continuing them, when new celestial messengers of the carbonaceous type shall visit our globe.

ART. LVII.—*Results of Experiments on Contact Resistance;* by Professor W. A. NORTON.

[Read before the National Academy of Sciences, April 21, 1876.]

THE experiments here referred to were undertaken with the view of determining the law of the diminution of the minute distance between two surfaces in contact, with the increase of the contact pressure; and its dependence on the extent, condition and nature of the surfaces in contact. Rectangular pieces of various substances $\frac{1}{8}$ inch in thickness, $\frac{1}{4}$ inch in width, and of

suitable length for clamping were used in the experiments. The lower piece was clamped to a horizontal iron bar, which was firmly clamped to the vertical pillars of the testing machine used in my former experiments on deflection and set, and was also firmly propped directly beneath the point where the contact occurred. The other piece, $\frac{3}{4}$ inch in length, was keyed to the under surface of the lever used in the same experiments, at the farther end. The weights were placed on a scale pan resting above this on the lever, and vertically over the surfaces in contact. The depressions of this end of the lever were determined by means of a micrometer screw, which gave the equal elevations of the other end to within $\frac{1}{4\,0\,0\,0}$ of an inch. The firmness of the lower contact piece and its support was frequently tested by causing the weights to press directly upon it, without the intervention of the lever. The small thermal error of the apparatus was carefully determined and allowed for whenever any perceptible change of temperature occurred during any single series of experiments; but the precaution was taken to secure a nearly uniform temperature during the progress of the experiments. The weights employed, in the more precise determinations, ranged from 2 ounces to 24 ounces. The apparent surface of contact varied from $\frac{1}{3\,2}$ of a square inch to a mere point. The touching surfaces were in some instances smooth, in others rough; and in the contact of plate glass with plate glass, highly polished. The decrement of contact distance was noted whenever a weight was put on, and the increment when the weight was removed, and in general the average of the two taken. By this means the thermal error, when the rise or fall of temperature was uniform, would be eliminated; as well as any error that might result from a change in the coefficient of the contact resistance, induced by the pressure and not passing off when the weight was removed. That errors from irregular variations of temperature, irregular variations of the coefficient of molecular resistance, and accidental causes, might be in a great degree eliminated, the mean of a considerable number of separate determinations was obtained in each case. A comparison of these means for sets of experiments differing in number, showed that the irregular and accidental errors were generally small. The initial pressure was the same in the different sets of experiments, and was very slight—being barely sufficient to secure a decided contact.

When a weight was applied the resulting diminution of the contact distance was generally greater than the increase that resulted from the removal of the weight. The reverse very rarely occurred; though the increment was sometimes equal to the decrement. It therefore generally happened that there was a slight contact set when the pressure was withdrawn. These

facts show that the application of the contact pressure was generally attended with a diminution of the coefficient of molecular resistance at the surface of contact. When the pressures were renewed at short intervals, the contact set at first observed was generally maintained, and often increased.

The following table gives the diminutions of the contact distance obtained with the several weights, 2 oz., 4 oz.., 8 oz., 16 oz., and 24 oz. It is to be understood that the numerical determinations given in the table are the means of a number of individual determinations. It thus happens that the decimals are carried beyond the reliable reading of the apparatus. The mean results of different sets of experiments are given in two instances. The apparent surface of contact was about $\frac{1}{32}$ of a square inch, except in the case of the contact of a flat surface with a round surface of sharp curvature, in which the area of contact was too minute to be estimated.

	Iron on Iron.	Same.	Average.	Iron on iron,	Same.	Average.
	Surf. smooth.	Same.		Flat surface on round surf.	Same.	
	In.	In.	In.	In.	In.	In.
2 oz.	0·000170	0·000162	0·000166	0·000165	0·000162	0·000163
4 "	·000250	·000285	·000267	·000240	·000275	·000257
8 "	·000340	·000325	·000332	·000320	·000275	·000297
16 "	·000450	·000425	·000437	·000410	·000425	·000417
24 "		·000500	·000500			

	Iron on brass.	Brass on brass.	Brass on brass.	Plate glass on plate glass.	Gen'l average	Reliable average.
	Surf. smooth.	Surf. smooth.	Surf. rough.	Surf. polished		
	In.	In.	In.	In.	In.	In.
2 oz.	0·000167	0·000170	0·000175	0·000170	0·000169	0·00017
4 "	·000256	·000250	·000267	·000212	·000251	0·00025
8 "	·000335	·000256	·000250	·000294	·000294	0·00029
16 "	·000412	·000410	·000400	·000350	·000404	0·00040
24 "	·000500	·000500	·000500	·000475	·000493	0·00049

On examining this table it will be seen,

(1.) That the diminutions of contact distance were very nearly the same, whatever was the nature, or condition of the surfaces in contact.

(2.) That they were nearly independent of the extent of the surface in contact; since they were nearly the same when the surfaces touched in a mere point, as when the surface of contact had an extent of one-fourth of an inch by one-eighth of an inch.

(3.) That the diminution of contact distance for an increase of one ounce in the pressure, was nearly inversely proportional

to the pressure. The fractions of an inch that would answer to this law are as follows: For 2 oz. 0·00017 in., for 4 oz. 0·00025 in., for 8 oz. 0·00033 in., for 16 oz. 0·00041 in., for 24 oz. 0·00046 in. These values differ but little from those given in the table as the reliable averages. The only material discrepancies occur in the results for 8 oz. and 24 oz. Now the table of results shows that in a few cases some cause was in operation to reduce the diminution of contact distance for 8 oz. to nearly the value observed for 5 oz. The same tendency was also often manifest in the individual experiments. If we reject the results for 8 oz. in these cases, that occur in the table, the average diminution of contact distance for a pressure of 8 oz., comes out 0·00032 in., and the discrepancy is reduced to 0·00001 in. Again the experimental result for the case of 24 oz. is 0·00003 in. larger than the law above stated calls for; but the individual micrometer readings were liable to this amount of error, and hence if the support had been depressed by this amount, by the 24 oz. weight, it would have escaped detection.

That the law of diminution of the contact distance which has been stated is very nearly, if not the exact law of Nature in the case, may also be inferred from the fact already stated, that the variation of contact distance is nearly if not entirely independent of the extent of the surface of contact. For if the contact area be diminished in any ratio, say 2 to 1, under the pressure of the same weight the pressure at each individual point of contact would be doubled, and the increment of pressure at each point, resulting from an additional weight of one ounce, would also be doubled. Now if we suppose the law, just referred to, to hold good for a given surface of contact, the diminution of contact distance at each point should be inversely proportional to the pressure on it, and therefore be half as great for the same increment of pressure there, as in the case of the larger area of contact; but in fact the additional pressure at a single point, resulting from an additional weight of one ounce, is doubled, and hence the diminution of distance should be the same as in the case of the larger area of contact.

We may conclude, therefore, that in the contact of surfaces, the force of molecular repulsion, in which the force of contact resistance consists, conforms in its variations very nearly, if not exactly, to the law that the decrement of the distance between the molecules, for the same small increment of pressure, is inversely proportional to the effective pressure by which the molecules are urged into closer proximity. If then we suppose the distance between the molecules to be denoted by x, and the effective molecular repulsion by r, and observe that x is a decreasing function of r, we may put $dx=-m\frac{dr}{r}$. This gives,

by integration, $x=c-m \log r$; or $x=m \log \frac{n}{r}$, in which n is a new constant. It appears then that the curve of the effective molecular repulsion, which resists contact pressure, is the logarithmic curve.

This force of molecular contact repulsion cannot be identical with the effective repulsion in operation in the interior of bodies, when they suffer compression; for the same force of pressure produces a vastly greater diminution of molecular distance at the surface of contact than in the interior of bodies. Thus, in our experiments, a pressure equivalent to 30 lbs. to the square inch, diminished the contact distance by $\frac{1}{25000}$ of an inch. This pressure operating on an iron rod one inch in length would compress it $\frac{1}{3000000}$ of an inch. The distance between its individual molecules would be reduced $\frac{1}{3000000}$ part. This is immeasurably smaller than the observed diminution of contact distance; and therefore than the diminution of molecular distance at the point of contact, if the decrease of contact distance consisted simply in the closer approximation of the contiguous molecules of the two surfaces. It is not improbable, however, that it consists in part in a compression of a thin layer of molecules at the surface, having a comparatively small coefficient of elasticity. If such a layer have a thickness as great as $\frac{1}{10000}$ of an inch, the compression it would receive from a pressure of 30 lbs. to the square inch, would still be 32000 times greater than a layer of the same thickness in the interior of a mass of iron would experience from the same pressure.

We must conclude, therefore, that the force of molecular contact repulsion has, for the same diminution of the distance between the molecules, an exceedingly feeble intensity in comparison with that of the internal molecular repulsion. It must operate then at greater molecular distances; and accordingly the range of its action must lie outside of that of the attraction of cohesion. In confirmation of this conclusion it may be stated that in none of the experiments was any evidence obtained of an attraction between the surfaces, operating outside of the contact distance.

It would seem, then, that the experiments discussed have served to establish the existence of an effective force of molecular repulsion, in operation at the surface of contact of bodies, whose sphere of action is external to the range of the attraction of cohesion for the same molecule, and which has a much feebler coefficient of intensity than the effective molecular repulsion exerted within the sphere of this attraction. They have also made known the law of variation of this force with the change of molecular distance, and shown that its coefficient of intensity is the same, or nearly the same, for the different substances used in the experiments.

ART. LVIII.—*On some Physical Observations of the Planet Saturn;* by L. TROUVELOT.*

DURING the last four years I have had many occasions to observe the planet Saturn, and to study its physical constitution under very favorable circumstances. My series of observations extends over more than a hundred nights, many of which were as good as could possibly be desired, both for the steadiness of the image, and for the amount of light.

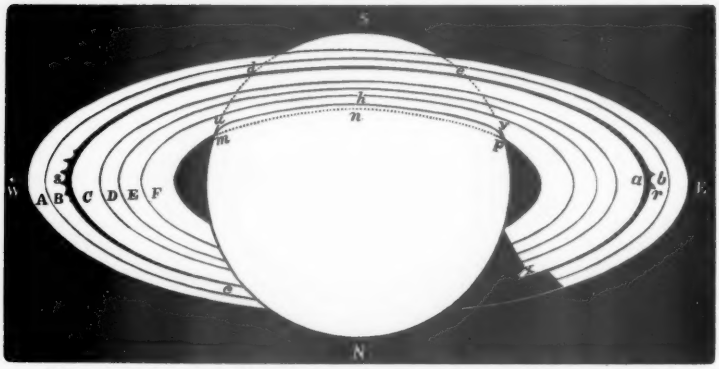
The observations on which this communication is based were made: 1. With the fifteen-inch refractor of the Harvard College Observatory, while I was employed by Professor Winlock in making the sketches for the series of the astronomical engravings published by him. By his kind permission I have availed myself of considerable of the data thus obtained. 2. With the twenty-six inch refractor of the Washington Observatory while it was still in the hands of Messrs. Alvan Clark & Sons. 3. With the six-and-one-quarter-inch refractor of my own Physical Observatory at Cambridge. During the past summer, I was honored with an invitation from Admiral C. H. Davis, Superintendent of the Naval Observatory, to visit Washington and make some sketches with the magnificent instrument of this establishment. I thus had an excellent opportunity to confirm all my previous observations. The powers used ranged, according to the amount of light and the steadiness of the atmosphere, from 140 to 700. On good nights, however, higher powers have been tried, but never with advantage, as the light lost by the use of high powers is generally of more importance for good vision than a superior enlargement with a reduced amount of light.

Numerous observers, among whom are such eminent astronomers as Sir William and Sir John Herschel, Otto Struve, Dawes, Bond, etc., have made careful studies of this planet; and it is not, therefore, to be expected that very important discoveries remain to be made by later observers. As I have had the opportunity of observing with the same instrument many of the celestial objects previously studied with so much success by Professor George P. Bond, it gives me the greatest pleasure to express my admiration for the accuracy and fidelity of his observations.

The following diagram, representing the outlines of Saturn and its rings, will facilitate my explanations, and give clearness to the subject:—

* Read before the Amer. Acad. of Arts and Sciences by William A. Rogers, Dec. 14, 1875.

1.

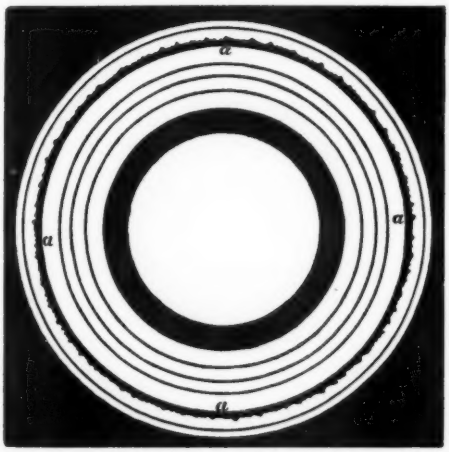


When looking at the rings, attention is at once attracted to a conspicuous dark line, apparently concentric with the outer margin of the rings, and boldly surrounding the planet, and adorning it by its sharp contrast. This dark line is known as "the principal division of the rings," and is shown at *a*, fig. 1. Owing to the effect of perspective, it always appears widest at the two extremities of its major axis, on that portion called "the ansæ," as there only, it is seen without foreshortening. I have carefully compared the intensity of this dark line with the sky outside of the rings, and inside of the ansæ; and I have always found it to be slightly lighter. All my observations also agree in showing this line as appearing a little narrower on the side farther from the observer, at *c*, fig. 1, than it appears on the opposite side, at *d*. This phenomenon could readily be explained by supposing that the outside margin of the ring *C* is on a plane higher than the ring *B*, and may, consequently, conceal a narrow portion of the dark line. The assumption of such an hypothesis seems to be fully supported by the observations, as will be shown hereafter. It is furthermore to be remarked, that the outside margin of the ring *C* has always appeared to me to be more sharply defined on that part of the ellipse farther from the observer than on the side nearest. The case is the same for the outer border of the ring *A*, which appears sharper on its northern than on its southern side. In both cases, the northern portion of the ellipse is limited by the matter composing the surface of the rings on their flat and illuminated side; while for the southern portion it is seen a little edgeways, and this may account for the vagueness of its outlines on this side.

Soon after the beginning of my observations, in October, 1872, my attention was called to a singular appearance not heretofore noticed, as far as I am aware. Two small, dark, angular forms,

r, fig. 1, were seen near the summit of the principal division of the rings on the following side, and apparently projected upon the ring *B*. After an interval of three hours, no sensible change could be detected in the position of these forms; and on the following day they were seen occupying about the same position. This phenomenon could easily be explained by supposing there were some sort of protuberances on the external edge of the ring *C*, casting their shadow under the oblique rays of the sun, which occupied then a proper position to answer to this hypothesis. But some days later, another of these singular forms was observed 180° from the first, on the preceding side, at *s*. This at once overthrew the supposition that they were shadows cast by protuberances existing on the ring *C;* since in this case the shadows would have been projected opposite the sun on the ring *C*, and not on the ring *B*. Since that time, I have rarely observed the planet without seeing some of these singular appear-

2.



ances, either on one side or the other, but generally on both sides. The number of these dark forms is variable. One, two, three, four, and even five, have been seen at the same moment, and on the same side. Though these forms are variable, and appear and disappear, I have never been able to detect in one night any change of position which could be ascribed to the rotation of the rings.

The most plausible explanation of the phenomenon which I can conceive is, that the inner margin of the ring *B*, which forms the outer limit of the principal division, is irregular, jagged, and deeply indented, as shown at *a*, fig. 2, which represents Saturn as it would appear to an observer placed above one of its poles.

As Bond speaks of the principal division of the rings as "not being perfectly elliptical," and as in one instance he has suspected that it "was narrower in some places," it is to be inferred that he had some faint glimpses of the phenomenon which I have observed, and which possibly may be more conspicuous now than twenty years ago.

But the fact that this phenomenon has not been observed earlier does not necessarily prove that it had no existence before; as it is well known, by those who have had experience with the telescope, that one may look for a long while at a celestial object, and miss perceiving what he will readily see when once he is told where to look, and what to look for. Seeing what is new and unsuspected is quite different from seeing what has been observed before.

Though no noticeable changes in the position of the dark angular forms could be observed in the course of two or three hours, it does not follow that the system of rings does not rotate upon an axis, as theory indicates; since the supposed indentations seen on the ansæ would be placed in the most unfavorable positions for showing their motion, if they have any, because it would be accomplished almost in a line with the visual ray, either approaching or receding from the observer.

Next to this division, but much less conspicuous, and to be seen only on very good nights, is a narrow, grayish, and somewhat diffused line, called "the pencil line," shown at *b*, fig. 1. I have never been able to trace this line all around the planet, as it diminishes very rapidly with the foreshortening, and is soon lost. Probably I have never traced it more than 30° or 40° on each side of the major axis of the rings. The pencil line has never appeared to me black and well defined, but rather grayish and diffused. Sometimes I have had the impression that it was irregular in width and in depth of tint.

These two lines are the only ones I have observed, which could, with a certain amount of probability, be said to be a separation of the rings; though they might just as well be depressions, or dark belts, especially the outer one. But the fact that they have been observed on both surfaces north and south, apparently corresponding in position, is in favor of their being real separations of the rings. Though I have repeatedly endeavored to see the planet through the principal division between *d* and *e*, fig. 1, I have never seen the faintest traces of it; and I am not aware that others have been more successful.

If the principal division of the rings is, in fact, what it is said to be,—viz: a space free from matter, and entirely disconnecting the rings *B* and *C*,—I do not see why the planet has never been seen through it. If the planet could be seen through that space, the dark line forming the principal division would be in-

visible from *d* to *e*, as the bright light of the planet would shine through in its place, and be undistinguishable from that of the rings. It may be objected that the invisibility of the planet through the principal division is due to the thickness of the ring *C;* but in this case, why should the black sky be seen, if the planet is invisible?

Besides the two dark gaps or divisions of which I have just spoken, the rings are subdivided by concentric zones or belts, which reflect light of different hues and intensity. Though only three of these belts are conspicuous, I have found by careful examination that there are six which I can always recognize whenever the illumination is good, and the image steady. These zones are represented on the diagram, fig. 1, at *A, B, C, D, E, F.* On several occasions, I have had a pretty distinct impression of seeing the whole surface, from *C* to *E* inclusive, grooved, as it were, by numerous narrow concentric belts. These impressions may have been illusory, as they were almost instantaneous; but I have since learned by experience, that, after all, rapid impressions are not so much to be discarded, as, quite often, even more fugitive impressions have proved in the end to be real. A striking instance in my own experience may be worth recording. This summer I made a study of the Horseshoe Nebula in Sagittarius with my 6¼-inch refractor. During the course of my observations, I was much annoyed by what appeared to me as faint ghost-like reticulated shadows projected upon the nebula. I at first thought I had left the reticule of squares ruled on glass in the eye-piece; but having convinced myself that this was not so, and the same appearance again presenting itself, I wiped my eye, but with no better result. As I experienced the same thing on other nights, I paid no more attention to it, thinking the trouble was in my sight. Some time afterwards, while in Washington, I had an opportunity of studying the same nebula with the great twenty-six inch refractor of the Naval Observatory. I was not a little surprised to see that the ghost-like reticule which I wanted so much to rub out of my eye while at home, was caused by dark channels in the nebula itself, which is divided on the preceding side by bright luminous patches, separated by dark intervals.

In order of brightness, the zones or belts composing the system of rings run as follows: *C, D, B, E, A, F; C* being by far the brightest, and *F* by far the darkest. The zones *A* and *B* have a bluish cast, or light slate color; *C* is of a bright luminous white; *D* is slightly grayish; *E* is a little darker; while *F*, which is very dark, is tinged with bluish purple.

A is separated from *B* by the pencil line; *B* from *C* by the principal division; while the others do not show any separation whatever, and are only limited by the contrast of their different

colors and shades, and seem to be in immediate contact. However, the different zones do not terminate abruptly where they come in contact, but seem somewhat blended into each other. This is especially the case between *E* and *F*. Though at that point the contrast between the two internal rings is very great, yet it is impossible to see any line of division, so much do they mingle at their point of contact.

On good nights, I have often observed on that part of the rings *A*, *B*, and *C*, seen on the ansæ, an unmistakable mottled or cloudy appearance such as is represented on Plate 1. This appearance was always more characteristic and better seen on the ring *C*, especially near its outer margin, close to the principal division. It would seem, as has been already remarked, that the ring *C* is on a higher level than that of the rest of the rings, and that the cloudy appearances observed there form by their accumulation some kind of protuberances of different heights and breadths. The bright spots resembling satellites, so often observed by Bond in 1848, when the plane of the rings was parallel with that of the ecliptic, were probably caused by the crests of some protuberances similar to those now seen on the ansæ. The form of the shadow thrown by the planet on the rings on Nov. 30, 1874, as shown at *x*, fig. 1, seems also to agree with this hypothesis. The curious and deep indentation of the shadow at *x*, in that part where it is projected on the outer border of the ring *C*, is perfectly explained on the supposition that this part of the ring is on a higher level. The same shadow, as it appeared projected on the rings *B* and *A*, also clearly indicates that the plane of these zones is on a lower level.

In order to find the shape of the surface of the rings from the observation of the form of the shadow thrown by the planet, I have experimented on a miniature representation of Saturn, illuminated by a lamp occupying the position of the sun, while my eye occupied the position of the earth. By successive trials in altering the shape of the miniature rings, I have soon found what must be the form of the rings in order to give to the shadow the same appearance which had been observed on the planet; and the result agrees with the explanation already given.

From the form of the shadow as it has appeared at different times during the last four years, and from the experiment just mentioned, it seems pretty clear to me, that, from the inner margin of the dusky ring *F*, the thickness gradually increases until it reaches the extreme border of the ring *C*, where it gently decreases, as indicated by the rounding of the shadow at this point; after which it sinks perpendicularly down, until it comes even with the general level of the rings *B* and *A*. The slightly curved appearance of the shadow of the planet during the present year, with its concavity turned towards its globe, also supports this hypothesis.

Though in general, the level of the ring *C* is always higher than that of the rest of the system, it does not seem, however, to be uniform and permanent, but varies, either by the rotation of the rings upon an axis, or by some local changes in the cloud-forms themselves; as in several instances I have observed quite rapid and striking changes taking place during the course of one evening in the indentation of the shadow shown at *x*, fig. 1. Sometimes the indentation appeared to increase, indicating a higher level; and sometimes to decrease, indicating a lower level.

That the thickness of the rings is increasing from the interior margin of the dusky ring to the outer border of the bright ring *C*, seems to be corroborated by the phenomena which I have observed on the dusky ring, and of which I shall speak presently.

On all favorable occasions, I have made careful searches on the dusky ring for the divisions suspected by Bond; but I have never had the faintest glimpses of them. The dusky ring appears to me to be continuous, though it is certainly not of the same thickness throughout. Whatever may be the material of which this ring is composed, it is quite rarefied; and it becomes more and more so as it approaches its inner margin. There, it seems to be composed of discrete particles, each of which reflects the light separately; and by applying high powers to telescopes of large aperture, I have had the impression that the supposed particles were more widely separated by the increase of magnifying power. I do not pretend to have seen distinct and isolated particles in the dusky ring; but by instants my impressions have been so decided, that it seemed as if only a little more favorable conditions were required to enable me to see separate corpuscles of matter. The appearance was somewhat like fine particles of dust floating in a ray of light traversing a dark chamber.

The inner border of the dusky ring, notwithstanding its dark appearance, is sharply defined on the dark sky within the ansæ; but it loses this sharpness of outline in that part which is seen projected upon the disk of the planet. There it appears very diffused and ill-defined.

The inner border of the dusky ring, as seen within the ansæ, forms a part of a perfect ellipse concentric with the other rings; but these graceful curves are remarkably and quite abruptly distorted where they enter upon the disk of the planet at *m* and *p*, fig. 1. At these points, they are seen turning up rapidly, describing a short curve; after which they continue parallel with the curves of the other rings until they meet at *h*. If the ellipse described within the ansæ should cross the planet without any deflection, it would be seen along the dotted line, fig.

1, and pass through *n*; while, on the contrary, it is seen above at *h*.

I was surprised, at first, by this singular phenomenon; but I at last satisfied myself with the following explanation: If we conceive the dusky ring to be made up either of vapors or of numerous small independent solid bodies, and, moreover, if we conceive the thickness of this ring as increasing from its interior margin to its outer limit, we shall have an easy explanation of the observed phenomena. When the matter composing this ring, whether solid or gaseous, is seen projected upon the disk of the planet brilliantly illuminated, it will be lost, and will individually disappear, absorbed by the irradiation of the bright light surrounding it, and it will remain visible only at that part where it forms a stratum thick enough to overpower the effect of irradiation.

The fact that the distortion of the inner margin of the dusky ring is not abrupt at *m* and *p*, where it enters upon the disk, but is gradual, seems to prove that the planet is less luminous on its border than elsewhere, providing the above explanation holds good; and this may be owing to the absorption caused by an atmosphere surrounding the planet.

Bond has represented the limb of the globe of Saturn as seen through the whole width of the dusky ring. In this he agrees with all previous observers. All the drawings of Saturn represent the limb of this planet as plainly and equally visible throughout the dusky ring, becoming invisible only where it enters under the internal margin of the ring *E*. In Bond's memoir, it is positively stated that Mr. Tuttle saw the limb of the planet through the whole width of the dusky ring. If these observations are correct,—as without doubt they are,—the solid particles, vapors or gases, composing this ring, must have undergone some changes of position since Bond's time; as by using the same instrument, and even one of almost double the aperture, I have not been able to confirm these observations.

During the last four years, I have never been able to see the limb of the planet Saturn under the dusky ring, beyond the middle of its width. As it enters under it at *m* and *p*, it remains quite distinct for a short distance; but, as it advances farther in, it diminishes gradually; and it entirely vanishes at about the middle, at *u* and *v*; as if the matter composing the dusky ring was more dense or thicker towards its outer border. This observation has been so carefully made, and so many times repeated, the phenomenon has been so distinctly seen, that there is not the least doubt in my mind as to its reality. Therefore it seems pretty certain that changes have lately taken place in the distribution of the matter composing the dusky ring.

As already shown, the substance composing the dusky ring

does not seem to be uniformly distributed; but seems moreover to be agglomerated here and there into denser masses, which I have often recognized upon that part of the dusky ring crossing the planet between *u* and *v*. These supposed agglomerations appeared as dark masses, intercepting the light of the planet. This phenomenon could not be attributed to dark markings on the planet, seen through the dusky ring; since there are no markings so dark and so small on Saturn. Neither could they be produced by the dark bands sometimes surrounding the globe of Saturn, as some traces would have been detected on the edge of the dusky ring, since these bands are usually wider than the transparent part of the dusky ring.

Of the planet itself I have little to say. It has certainly a mottled or cloudy appearance, like Jupiter. The clouds of Saturn are more finely divided, like certain forms of the cirri clouds of our own atmosphere. The cloudy appearance of Saturn, of course, is not so easily seen as that of Jupiter. It always requires a good steady night to see it.

I have never seen the planet striped with a large number of parallel bands, such as some observers have described. Three or four form the extreme limit. Nor have I seen the bands so conspicuously marked, so regular, so distinct in outline, and so dark; the equatorial band being always by far the most conspicuous, while the others were barely perceptible. The equatorial belt has always appeared to me to be slightly tinged with a delicate carmine red, very much like the equatorial belt of Jupiter; only the pink color of the former is much fainter. In no instance could I compare the color of this band to "brick red," as it is commonly described.

Like the equatorial belt of Jupiter, that of Saturn is variable in width, and changes its form as well as its position. It is usually composed of two grayish, irregular bands, forming its limits north and south, between which are seen flocculent pinkish cloud-forms.

The general color of the planet differs from that of the rings, in being of a slight warm brown in which there is a yellowish tinge. The contrast of color with the rings is better seen by the use of very high powers.

To conclude: my observations show,—

I. That the inner margin of the ring *B*, limiting the outer border of the principal division has shown on the ansæ some singular dark angular forms; which may be attributed to an irregular and jagged conformation of the inner border of the ring *B*, either permanent or temporary.

II. That the surface of the rings *A*, *B*, and *C*, has shown a mottled or cloudy appearance on the ansæ during the last four years.

III. That the thickness of the system of rings is increasing from the inner margin of the dusky ring to the outer border of the ring *C*, as proved by the form of the shadow of the planet thrown upon the rings.

IV. That the cloud-forms seen near the outer border of the ring *C* attain different heights, and change their relative position, either by the rotation of the rings upon an axis, or by some local cause; as indicated by the rapid changes in the indentation of the shadow of the planet.

V. That the inner portion of the dusky ring disappears in the light of the planet at that part which is projected upon its disk.

VI. That the planet is less luminous near its limb than in the more central parts, the light diminishing gradually in approaching the border.

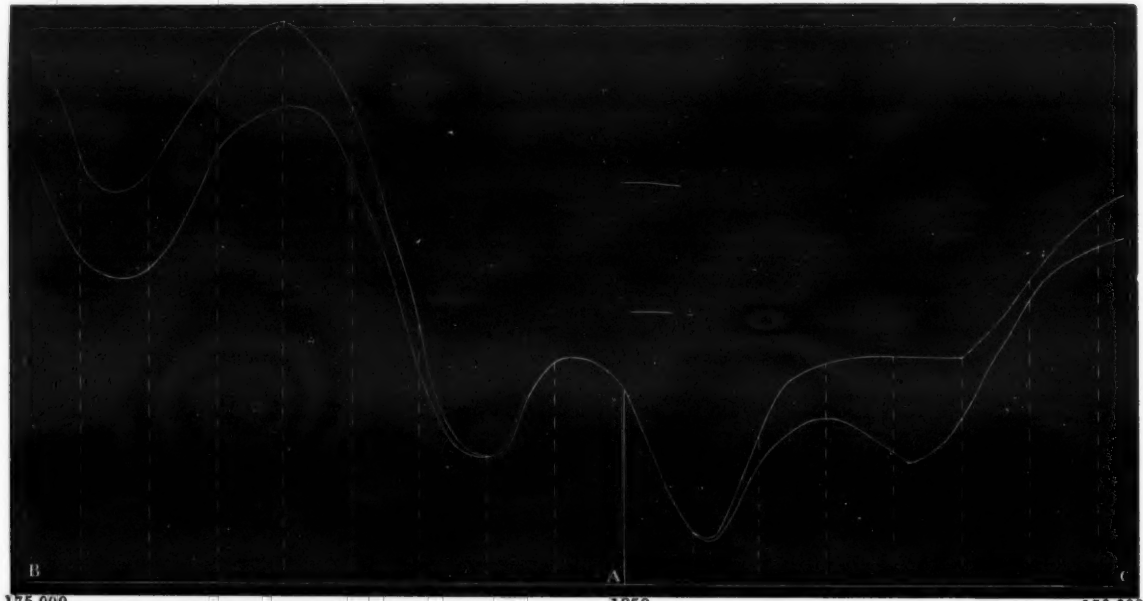
VII. That the dusky ring is not transparent throughout, contrary to all the observations made hitherto; and that it grows more dense as it recedes from the planet; so that, at about the middle of its width, the limb of the planet ceases entirely to be seen through it.

VIII. And, finally, that the matter composing the dusky ring is agglomerated here and there into small masses, which almost totally prevent the light of the planet from reaching the eye of the observer.

Cambridge, Dec. 1, 1875.

Art. LIX.—*Curve of Eccentricity of the Earth's orbit;* R. W. McFarland.

The diagram on the following page gives the curve of eccentricity as found in Croll's work, and also in Stockwell's. The former was computed with a view of explaining the climate of past time; the latter, in examining the moon's mean motion. It will be seen that the curves have the same general form, differing in the value of the ordinates, more than in the position of the maximum and minimum points. I have recomputed the values by Le Verrier's old formulæ, and find Croll's figures correct in most cases, and not in error to the amount of ·001 except in one instance. My work extends over 1,100,000 years, and is for points nearer together than Croll's. Stockwell's is doubtless nearer correct than the other, but there is substantial agreement. The two curves for the last 40,000 years, and for the next 30,000, are almost identical; so nearly is this the case, that only one line is drawn in the figure for those periods.



Curve of eccentricity of the Earth's Orbit. The upper line Croll's; the lower, Stockwell's.

The following table gives the difference between perihelion and aphelion, the sun's mean distance being 92,000,000 miles.

Before 1850. years.	Croll. miles.	Stockwell. miles.
175,000	8,400,000	6,750,000
160,000	6,700,000	5,150,000
140,000	6,360,000	4,910,000
120,000	7,920,000	6,590,000
100,000	8,700,000	7,400,000
80,000	7,320,000	6,290,000

At 40,000 the difference disappears.

Ohio Agricultural and Mechanical College, Columbus, April, 1876.

ART. LX.—*On a Bolide of January 31st, that passed over Kentucky;* by J. LAWRENCE SMITH.

ON the afternoon of the 31st of January, at five and one-half o'clock, while crossing one of the streets of Louisville, my attention was suddenly arrested by a magnificent meteor crossing the heavens. I first saw it at 60° above the horizon, and it disappeared to my view behind the houses at an elevation of about 20°. It was pear-shaped, and very bright, and remained in view for two or three seconds. Its apparent size was about one-sixth that of the disk of the moon. It did not separate while under my observation, nor did I hear any noise. On asking, through the medium of the public prints, for the observations of others, I received some fifteen communications, from an area one hundred and twenty miles in diameter.

To a number of the observers an explosion was visible, producing several flashes of light, of different colors. This occurred about ten degrees above the horizon. On exploding, all the fragments disappeared instantly except the largest, which also disappeared before reaching the horizon. Some observers saw sparks flying off from the ball, and a short stream of light behind it. One or two think they heard a whizzing noise and at the time of bursting heard the explosion. All agree in stating that the direction was from northwest to southeast. Nothing has yet been heard of any fragments having been collected. My opinion is that it fell about the range of the Cumberland Mountains in Kentucky, or in the northeast of Tennessee.

This is the third bolide in three consecutive years that it has been my good fortune to witness, in their passage over Louisville, but the fragments of none of them have been obtained. They all were passing from the northward to southward.

ART. LXI.—*Notes on the Sensitiveness of Silver Bromide to the Green Rays as modified by the Presence of other Substances;* by M. CAREY LEA.

SEVERAL investigations made at different times during the past years on the sensitiveness of silver bromide to rays of different refrangibilities, led me to the conclusions: 1st, that its sensitiveness to the different rays could be distinctly modified (increased or diminished) by the presence of various bodies, colored and colorless; 2d, that no relation could be traced between the color of the modifying body and the refrangibilities of the rays to which the sensitiveness was modified. During the past winter, I have carefully re-examined the question, which is an important one both in its theoretical and practical relations, and have found my conclusions in all respects confirmed. And I have during the past winter been occupied with a single portion of the subject, namely, the action of the green rays, as a special study.

In this investigation I have pursued the same general method as before; that is, I have used colored glass whose transmitted rays have been carefully studied with the spectroscope. There is no doubt in my mind that this method of examination is capable of giving results as valuable as those obtained by the use of the spectrum. It may be said in fact that the subject requires for its full elucidation, the use of both methods. To those who may imagine that the results of the exposure to the spectrum are the more reliable, it may be interesting to have specified the weak points of that method.

The *relative strength* of the impression produced by different portions of the solar spectrum on a sensitive surface will always depend upon the intensity of the light employed and the length of exposure. It has already been proved that silver iodide and bromide are sensitive to every part of the spectrum. It follows that any and every part of the spectrum may be photographed upon plain iodide or bromide if only the exposure is sufficiently prolonged. The longer the exposure, the stronger will be the impression produced by the less refrangible rays as compared with the more. Also, it is known that by a system of masking, Prof. John Draper has succeeded in photographing the whole spectrum at once; that is to say, he was able to hold back the action of the more refrangible rays until that of the less was sufficiently strong. The masking was of course done with red or yellow media. Now, when pigments of these colors are extended over sensitive films, what is this but a sort of masking, which retards the action of the more refrangible

rays while freely permitting that of the less? Even supposing these pigments to be chemically inert they would check the action of the blue end of the spectrum and render it possible by a longer exposure to obtain both together. Even a longer exposure would not be absolutely essential, a more powerful or a longer development may take its place, being rendered possible by the diminished impression of the blue end.

If, then, it is alleged that by coloring a film of silver bromide with *red* pigments, the sensitiveness to *yellow* rays is increased, we are at once moved to reply that such a result is no proof of a chemical or photochemical action exerted by the red pigment; that precisely the same result might be expected if the red substance were chemically inert, or if it were extended over a glass surface and simply interposed in the path of the rays, between the prism and the film, without even coming into contact with the latter. Many results that have been published are liable to this fatal objection. It has been proposed to modify the form of experiment by applying the color to the front of the plate and exposing on the back, through the glass. But even this does not remove the difficulty. The collodion film containing the silver bromide is exceedingly thin and when moistened, very porous and absorbent. Any soluble color applied, dissolved in water or alcohol, instantly penetrates it through and through and even moistens the glass under it. And all the colors mentioned by other experimenters as having been subjected to this experiment, are soluble. It is on these results that theories have been based, and they are all susceptible of full and complete explanation in the manner just mentioned.

In matters of photographic experiment such as these now under discussion, there are always three distinct factors: The sensitiveness of the matter, the force of the impression (depending upon the intensity of the light and the length of exposure), and the development. This makes the investigation difficult and deceptive. If we take two identical sensitive films, and submit them to the same exposure, we may get quite different results by varying the development, or with an identical film and development, by varying the exposure. The amount of error and deception liable to be introduced in this way is known to none but those made familiar with it by experience, and consequently for accurate results, these sources of error must be eliminated. There is but one way of doing this: a film must be taken, one portion of it must be washed over with the substance whose action is to be studied, and then the two portions, the plain and that which has been treated, must be simultaneously exposed and simultaneously developed. Both portions must receive the same rays, of equal intensity and for an

equal time, the development must be made by a bath applied to both portions equally and for an equal time. If these conditions are not maintained, the result will be deceptive. The *intensity* of light must be the same and the *duration* of exposure, because the *relative* effect of the different rays will always be proportionate to them. The same plate exposed to the same image for a double time, or for an equal time to an image of double intensity, will give a final result in which the relative strengths are totally different. The relative strength of different parts of the image is also largely modified by the development. I am therefore justified in affirming that no strictly comparative trial can be made except the two images, on the colored and uncolored films, be received on the same plate, simultaneously and for the same time, and be simultaneously and equally developed.

These conditions have never yet been fulfilled in the case of spectral observations. By the use of colored glass they may be maintained with absolute exactness. And when colored media can be obtained which exclude all but a given band of consecutive rays, the effect of colored substances added to the film of silver bromide, in modifying its sensitiveness to this band of rays, may be accurately fixed. Having previously, with the aid of the spectroscope, determined the exact character of this band, we are enabled to speak very decisively of the action of the rays of which it is composed.

In the present investigation I have limited myself to a single question: Does there exist any red substance which is capable of increasing the sensitiveness of silver bromide to the green rays?

For the purpose of this examination, I used three thicknesses of very dark green glass, the limiting wave-lengths of which had been many times measured with closely corresponding results; the widest variation was two minutes of arc, which when it is considered how gradually the band fades out at its borders, and how very faint the illumination is at its extreme limits, is fully as close an approximation as could be expected. The extreme limits of the band, measured to the limit of visibility, were $\lambda 497$ and $\lambda 581$. But the extremities showed an illumination too feeble to have any effectual result. Cutting off the very faint light, the band was reduced to $\lambda 517$ on one side, and $\lambda 569$ on the other, and the rays between these limits may be taken as those whose results were observed.

In order to register the effects produced, a glass negative of a suitable character was placed under these three glasses, and under the negative, a glass carrying the film to parts of which

the coloring matters had been applied. Complete contact was obtained by a pressure frame, and the exposure was made directly to the sun. With a good sunlight, in winter, the exposure was about 45 seconds, corresponding to perhaps 20 or less of summer light. The development was in all cases the alkaline, viz: pyrogallol, and ammonium carbonate controlled with potassium bromide.

As already said, the main object of the research was to arrive at a solution of the question whether any red pigment could be found which would enhance sensibility to the green rays. The following were tried:

Ammonium hæmateate.	Murexide.
Santaline.	Aurine.
Coralline.	Carminic acid.
Rosaniline.	Naphthaline red.
Ferric sulphocyanide.	

In addition to these substances of well-established composition, some pigments were tried whose commercial names are:

Cardinal red.	Rouge ponceau.
Saffranine.	Bordeaux claret.
Cerise.	

With the single exception of coralline, not one of these substances produced the slightest increase of sensitiveness to the green rays.

It was my intention, in the case of finding any red pigments which increased the sensitiveness to green light, to make a careful study of their absorption spectra by means of the spectroscope, but as none such were found except coralline, its spectrum only was examined.

The power of coralline, however, to increase the sensitiveness of AgBr, to green light, cannot be considered as any function of its color, for two most excellent reasons.

1. Coralline exhibits a *still more marked tendency to increase the sensitiveness of AgBr to the red ray than to the green.* This action on the red ray was observed and published by me in March, 1875, and completely disproves of the theory of any special action of coralline upon the green ray. There appears to be a heightening of sensibility to the less refrangible end of the spectrum, rather than to any particular ray.

2. The action on green light is not a function of the color of coralline, because *it is easy to destroy that action without destroying the color.* This singular result is accomplished in the following way.

Coralline appears to be the ammonia salt of a yellow acid. If we place a drop or two of a weak acid, acetic or gallic, in a capsule, and add a few drops of alcoholic solution of coralline,

the deep red color of the solution passes to a clear yellow. With the addition of more coralline solution, the color reappears with its full brilliancy. But the solution, if too large a proportion of coralline to the acid has not been added, is found to have wholly lost its power of exalting sensitiveness to the green rays, although the amount of color applied be made the same in both cases.

Absorption Spectrum of Coralline.—With a moderately strong solution and a narrow slit, the transmitted band is confined to the red rays. As dilution increases, the band widens, passes the D lines, and transmits all the yellow rays. In all cases the band is continuous, and shows neither intervals nor a second maximum.

Coralline, then, forms no exception to the general rule, as above deduced from the examination of fourteen substances of strong red coloration.

Action of Colorless, or nearly Colorless, Substances on the Sensitiveness to Green Rays.

The following substances examined, gave an increase of sensitiveness:

Potassic arsenite.	Morphia acetate.
Argentic arsenite.	Tincture of capsicum.
Salicine.	Ammonium valerate.
Codeia.	Caffeine?

It appears, therefore, that it is not among the colored, but the colorless substances, that we must look for those capable of enhancing sensitiveness to green light. While not a single red substance could be found that possessed that property, no less than eight colorless substances exhibited it.

The following substances neither increased nor diminished the sensitiveness:

Ammonium hippurate.	Phloridzin.
" mucate.	Parabanic acid.
" malate.	Tincture of aloes.
Plumbic arsenite.	Potassic formate.

It was a little uncertain whether two of these substances, phloridzin and potassic formate, did not give a slight increase of sensitiveness.

The following colorless substances distinctly diminished the sensitiveness to green light:

Brucia.	Gentianine.
Strychnia.	Podophylline.
Narcotine.	Aconitine.
Daturine (tinct. of stramonium.)	Asparagine.
Acid ammonium urate.	Berberine.
Piperine.	

Finding, therefore, no red substance capable as such of increasing the sensitiveness of AgBr to green light, and, on the other hand, many colorless substances which have that effect, I am entirely confirmed in the opinion originally expressed in the pages of this Journal, that there exists no relation between the color of a substance and that of the rays to which it increases the sensitiveness of silver bromide.

Philadelphia, March 13, 1876.

ART. LX.—*Contributions from the Sheffield Laboratory of Yale College.* No. XXXIX.—*On the Chemical Composition of Durangite;* by GEORGE J. BRUSH.

IN an article* on this rare mineral, published in 1869, I expressed the hope to make further examination of its chemical composition whenever sufficient material could be obtained for this purpose. Several years elapsed before any new discoveries of the mineral in Durango were made. I am again indebted to Mr. Henry G. Hanks of San Francisco for a new supply of the crystals obtained in recent explorations. These crystals are much smaller than those previously examined, being from one to three millimeters in diameter, and they are of a darker shade of color. The former were loose detached crystals, while these are associated with, and in some cases attached to, rolled fragments of crystallized hematite and cassiterite. The density of the small dark colored crystals is 4·07, while that of the purest of the bright colored crystals before described is 3·937. In all other physical characters there is a perfect correspondence between the two varieties.

The chemical examination of the dark colored small crystals has been undertaken, at my request, by my assistant Mr. George W. Hawes, first to estimate the amount of fluorine in the mineral, which in two determinations he found to be 7·67 and 7·49 per cent, and Mr. Hawes has also placed at my disposal for this article a complete analysis of this variety of the mineral. The fluorine was determined directly by Wöhler's method as modified by Fresenius.† To determine the arsenic acid, and the bases, the mineral was decomposed by sulphuric acid, and the arsenic weighed as sulphide: the alumina, iron and manganese obtained in the analysis were carefully examined to ascertain their purity. The soda and lithia were

* This Journal, II, xlviii, 179.

† Fresenius' Quantitative Analysis (Johnson's edition), p. 406.

weighed as sulphates and then converted into chlorides and separated by ether and alcohol.

The results of the analysis are as follows:

	I.	II.
Arsenic acid,	53·11	----
Alumina,	17·19	----
Ferric oxide,	9·23	----
Manganic oxide,	2·08	----
Soda,	13·06	----
Lithia,	0·65	----
Fluorine,	7·67	7·49
	102·99	

The percentage of fluorine, 7·67, corresponds to 3·23 per cent of oxygen, which, being subtracted, the analysis foots up 99·76, and calculating the percentages of the elements we have the following:

	As	Al	Fe	Mn	Na	Li	O	Fl	
	34·63	9·18	6·50	1·45	9·69	0·31	30·33	7·67	= 99·76
Atomic ratio,	·462	·335	·116	·026	·421	·044	1·894	·404	
	·462		·477		·465		2·298		

Multiplying this ratio by the quantivalence of the elements we find that the ratio of $\dot{R} : \ddot{R} : \dot{As}$ is 1 : 3 : 5 with 9(O, Fl.)

The formula may therefore be written $(Na, Li)^2$ $(\dot{A}l, \dot{F}e, \dot{M}n)$ $As^2(O, Fl_2)^9$

The ratio of oxygen to fluorine in the mineral is as 9·4 : 1.

This is a confirmation of the conclusion drawn by me from the analysis of the lighter colored crystals described in the original paper.*

The mean of my two analyses gave:

Arsenic acid,	54·16
Alumina,	20·35
Ferric oxide,	4·92
Manganic oxide,	1·43
Soda,	11·76
Lithia,	0·75
Fluorine,	undetermined

The variety examined by Mr. Hawes contains less alumina, and considerably more iron, which accounts for its darker color and slightly higher specific gravity. His results prove the mineral to be an arseniate analogous in chemical composition to amblygonite as suggested in my previous paper.

* Loc. cit.

ART. LXIII.—*The Geological Survey of Brazil. First Preliminary Report made to the Counsellor Thomaz José Coelho de Almeida, Minister and Secretary of State for Agriculture,' etc.;* by CH. FRED. HARTT, Chief of the Geological Commission of the Empire of Brazil. Rio de Janeiro. 1876.*

ON the first of May, last year [1875] I had the honor of being appointed chief of the Commission charged with the undertaking of a geological survey of the Empire. At the same time Dr. Elias Pacheco Jordao was chosen assistant, and Messrs. Orville A. Derby and Richard Rathbun were appointed assistant geologists. The government having given me authority, I engaged, as the photographer of the Commission, Senhor Marc Ferrez, photographer of the Royal Navy.

While awaiting instructions, and with the permission of his Excellency the Minister of Agriculture, I went with Commander E. P. Wilson to the district of Sao Gonçalo, in the southwestern part of the province of Minas Geraes, for the purpose of inspecting the auriferous tract pertaining to a grant in which the latter was interested. I examined with care the region between Bella Vista, on the Don Pedro II railroad and Sao Gonçalo, including the gold mines of that locality and in the vicinity of the city of Campanha, verifying the occurrence of gold in three distinct deposits.

First, it is found in gneiss of what appears to be the upper part of the Archæan series (Laurentian), the metal being distributed in more or less irregular veins, apparently conforming in direction with the stratification of the rocks. Throughout this section the gneiss is very much decomposed, remaining, however, *in situ*, the decomposition at times extending to a depth of 30 meters or more. While in the solid gangue the proportion of gold is not great enough to pay the cost of working, it has been extracted with profit in many places from the decomposed portion of these same lodes. It is quite probable that this softened rock contains proportionally more gold than the solid gneiss, owing to the accumulation of the contained

* Translated and arranged for publication in this Journal by Theo. B. Comstock, Ass't Professor, in charge of Geological Department, Cornell University, Ithaca, N. Y. This document has not yet been published in Brazil. A copy of the original manuscript in the Portuguese language has been kindly furnished to the translator, with full liberty of action. The report has been shortened by the omission of not a little concerning the details of the Survey, which can have no special interest to the readers of this Journal. The mode of arrangement and construction of sentences differs somewhat from the original, but mainly in cases in which conciseness is gained without the sacrifice of perspicuity. Statements of fact or opinion will be found to correspond as closely as possible with the ideas of the author. Explanatory words within brackets are added by the translator. Words enclosed in parentheses occur thus in the original.—[T. B. C.]

metal of the lower portion in this part of the vein. Action of this nature was first demonstrated by Dr. James E. Mills in the auriferous district of Rio Grande do Sul and has been confirmed by the observations of Viscount de Barbaçena in his mineralogical studies of the auriferous gneiss of Minas Geraes.

Secondly, the gold occurs in the lower part of a deposit of red earth, which covers the whole surface of this region. This is a mechanical mixture of the ingredients of the decomposed gneiss, the local origin of which is not perfectly evident. All parts of the earth are not equally rich, and the gold is probably distributed in some relation to the outcrops, as has been shown by Dr. Mills in the eastern part of the province.

Thirdly, some gold is found in the alluvial deposits of the river-valleys, and in the vicinity of the ancient excavations of Sao Gonçalo and Campanha; the abundant "waste" also contains a considerable quantity of the metal.

Notwithstanding the small amount of gold and the fact that the richer deposits have already been extensively washed, this section appears to be worthy of scientific study, and, probably, by the application of methods similar to those employed in the California *placers*, the region may yet become productive. To this end are required the detailed exploration of this part of the country, the limitation of claims and the introduction of a cheap method of extraction. A survey of the character mentioned will probably be soon made.

Last year, Dr. Mills spent about six months in the study of the auriferous region of Minas Geraes, where he succeeded in discovering and applying the law of the distribution of gold, especially of its occurrence in the series of rocks characterized by the presence of *itacolumite*,—a law extremely important in its bearing upon the future development of the resources of that province. This gentleman has promised to give me a complete report, in which he will not only enunciate and illustrate this law, but will also include all the scientific results of his interesting explorations.

For several years past I have been engaged in the systematic examination of the border of the Brazilian plateau for the purpose of discovering and critically studying the different geological formations, which are there better developed and more fossiliferous than in the interior, being convinced that I could thus most quickly obtain a sure basis for the study of the general geology of the country. Having received instructions for continuing those studies by beginning in the northern provinces and proceeding southward, I judged it best to inaugurate the labors of the Commission by the exploration of the coast of Pernambuco. On the 10th of July [1875] I left Rio for that province, accompanied by Drs. Jordao and Freitas, and Senhor

Ferrez. Opening a provisional laboratory [in the City of Pernambuco], I commenced the examination of the vicinity, soon discovering limestone beds of the Cretaceous formation containing many species of fossils. The explorations were continued northward as far as Catuáma. At Maria Farinha, Cretaceous rocks were found so rich in fossils that several weeks were spent in carefully studying the formation, making a map of the locality, determining accurately the position and sequence of the strata, and collecting enormous quantities of fossils, among which are very many new species. Other collections were obtained from the vicinity of Olinda, from Iguarassú, from the island of Itamaracá, and at Catuáma.

I studied with especial care the limestones which are used for lime-making, analyses of which will be given in my report, and I am also preparing for the same report a chapter on the manufacture of lime and the construction of calcining furnaces.

The examination of the coast was then continued as far as Santo Agostinho, including a reconnoissance along the line of the railroad to Una, with excursions from several points upon both sides. The geology of this portion of the country is, however, extremely monotonous and of little interest.

At the same time I examined carefully the reefs along the coast,—whose geological features are of the highest importance to the country. As I have already indicated to your Excellency, these are of two classes: 1. *Coral Reefs*, composed of calcareous material derived from the débris of certain species of Polyps, Acalephs, and calcareous plants, and 2. *Consolidated Praias* [Beaches], made up of compacted siliceous sand. The reef of Pernambuco is a representative of the latter class This I examined very minutely, and, with the aid of Drs. Jordao and Freitas, made a map of a portion of it. Senhor Ferrez, under my direction, procured a fine series of photographs exhibiting its structure and appearance.

In the study of these reefs a magnificent collection of corals was obtained, including hundreds of large specimens, with many new species. Along with these, and with very little trouble, we gathered large numbers of marine animals, such as fishes, Echinoderms, Crustaceans, etc., etc., among which there is an extraordinary variety of unknown forms.

In September I went with the members of the Commission to make a reconnoissance along the Sao Francisco River to a point a little above the rapids of Paulo Affonso. We ascended the river in a sailing-boat as far as Piranhas, the limit of navigation. At that place, thanks to Senhor Ventura, we found prompt conveyance to the falls, where we remained eight days. Senhor Ferrez took a series of views of the most characteristic points. This was an extremely laborious task, and I cannot but com-

mend him for the firmness with which he struggled against great difficulties and for the good results that he obtained. As the rocks of the *cachoeira* [rapids] are excessively black and the water is white, it was very difficult to photograph both at the same time. On this account I thought it better to make several separate photographic studies of parts of the *cachoeira* which could be mounted as one picture. I hope that I shall be able, by means of the geological, topographical and photographic material collected, to present clear and exact ideas of this wonder of Brazil.

From this place a trip was made to the Serra* de Maria Farinha, distant about five *leguas*.† From the summit of this ridge, at an altitude of two thousand feet or more, may be seen a very large portion of the provinces of Sergipe and Alagoas, with parts of the provinces of Bahia and Pernambuco, and thus a very accurate idea of the topography of the included area may be obtained. All this portion of the country is composed of gneiss and related rocks, forming a plateau less than one thousand feet in height, and nearly level or with very slight undulations. As the region is arid, there has been scarcely any decomposition of the rocks, and the effects of water action are not very evident, owing to the absence of rain during the greater part of the year. There is no vegetable mould, but the rock is covered with a layer of sand a few inches in depth. The vegetation is such as is peculiar to arid plains—gigantic cactuses, the *xique-xique*, *faxeiro*, *mandacarú*, etc., being abundant. The rivers run in shallow channels, and are completely dry during a great part of the year, as are also the small lagoons which abound on the plain just as upon its continuation in the interior of Bahia.

From point to point peaks or short *serras* rise abruptly from the plain, like islands in the sea, seldom attaining an altitude greater than twenty-five hundred feet. In the provinces of Sergipe and Alagoas the serras are commonly composed of gneiss or some other rock of the same series. Between Piranhas and the rapids, however, small ridges of sandstone are encountered, and in the provinces of Bahia and Pernambuco, in the neighborhood of the Sao Francisco River, there are large serras and high *chapadas* [table lands] composed of the same rock. Such are the serras of Tacaratú. Long ago this sandstone covered the whole of this region; but by the action of the sea during the elevation of the Brazilian Plateau, and afterward by the action of the pluvial waters, these beds were denuded over a large portion of the country, leaving only the isolated fragments now forming the table-topped hills which abound in the valley of the

* The term *serra*, as used in Brazil, signifies a rocky ridge, usually more or less serrated in outline, although even table-topped hills are often thus designated.—[T. B. C.]

† The Portuguese *legua*, or league, is equivalent to nearly 1·6 English miles.—[T. B. C.]

Sao Francisco. This river once ran over these beds at a height of one thousand feet, more or less, above its present level, excavating its channel in the sandstone until it had cut through to the gneiss. Above the rapids the river now courses almost over the surface of the plain, its channel being but slightly indented; but upon arriving at the rapids it is suddenly precipitated by a series of magnificent waterfalls through an exceedingly narrow gorge, the depth of which immediately below the rapids is from 80 to 90 meters. This gorge, or cañon, with its walls nearly or quite vertical, extends as far as Piranhas, the river in this portion being much broken by rapids. Below Piranhas the river valley still maintains its cañon-like character, although its width is increased.

Like Niagara, these falls are slowly retroceding, but in a different manner. * * * * *

At the Cachoeira de Paulo Affonso the water passes over gneissic rocks. These do not here suffer decomposition or disintegration by frost, but they are much eroded by transported sand and stones, which produce extraordinary effects, by excavating innumerable pot-holes that soon communicate and allow masses of the rock to fall away. In my final report, the region of the cachoeira will be very carefully described, as well as the geology and physical geography of the lower Sao Francisco.

We returned to Pernambuco at the end of six weeks, and a few days later the bulk of the collections, filling sixty large boxes, were sent to Rio de Janeiro.

Dr. Jordao becoming ill at this juncture, I permitted him to return to the capital [Rio.] As my two assistants, Messrs. Derby and Rathbun, had not yet arrived, and beginning to feel the need of help, I called upon my former assistant, Mr. John Caspar Branner, who, being then in Rio, came at once to my aid, performing very valuable services. He is still employed by the Commission.

After shipping the collections, I returned to Maria Farinha, with Dr. Freitas and Mr. Branner, in order to finish the study of the Cretaceous beds and to examine the coral reefs. In ten days we returned again to Recife [another name for the city of Pernambuco] with a large vessel loaded with fossils, etc. Having been informed that your Excellency desired to exhibit some of the results of the Commission at the National Exposition [held at Rio Janeiro, January, 1876] the new collections were packed in seventy more cases, and I returned with them to the capital in December, accompanied by Senhor Ferrez. * *

While at Pernambuco, I procured a large barque from Mr. Frederico Soares, of Maria Farinha, and sent Dr. Freitas and Mr. Branner to explore the geology of the coast and its reefs as far as Parahyba do Norte,—a trip which was made with good results.

Afterward, Dr. Freitas returned to Iguarassú, where he obtained a fine collection of Cretaceous fossils, including many specimens of shark's teeth and of the teeth of an enormous reptile which is unknown to me. Mr. Branner then continued his study of the coast south of the Cape of Santo Agostinho, examining the reefs, from which he has sent me an interesting collection of corals and other objects, embracing many new species. He also sent photographs of a number of important points. In the beginning of February [1876], Messrs. Freitas and Branner, after sending me forty additional boxes of specimens, went to Aracaju, in the province of Sergipe, to study the Cretaceous deposits. They have already [March 5] made a large collection of fossils, especially of *Ammonites*, *Ceratites*, *Natica*, *Janira*, etc., with numerous forms not before obtained from Brazil. * *

Upon arriving at Rio de Janeiro, a building was hired, the collections were unpacked, and I began to arrange a series of specimens for the Exposition, Dr. Mills assisting me in the work. About the middle of the month [December, 1875] Messrs. Derby and Rathbun arrived, bringing new collections, including a typical series of the Carboniferous and Devonian fossils of the Amazonas and some North American fossils to compare with them. These gentlemen at once aided me in the preparations for the Exposition, and while this lasted they took charge of the other collections. In the meantime Senhor Ferrez mounted for the Exposition a collection of one hundred photographic views and prepared two albums containing a nearly complete series of the photographs taken for the Commission. As it was possible to expose but a small portion of the collections, there were exhibited only a series of the Cretaceous rocks and fossils, with another series illustrating the structure of the reefs, and the collections brought by Messrs. Derby and Rathbun. * *

On the 1st of February, Messrs. Derby, Rathbun and Ferrez were sent to Bahia, to commence the study of the geology of the vicinity and to continue the examination of the reefs. They established themselves at the station of Plataforma, and have to this date [March 5] been engaged in tracing the limits of the areas occupied by the different formations at the northern part of the Bahia de Todos os Santos [Bay of All Saints], in collecting Cretaceous fossils, and in the study of the reefs. Already they have obtained a large quantity of fossils,—teeth, bones and scales of reptiles and fishes, together with Mollusks and Crustaceans. In connection with the study of the recent formations and the reefs, they have also made a splendid collection of marine animals.

Two years ago, Mr. Herbert H. Smith, one of my assistants on the Morgan Expedition of 1870, was engaged in scientific studies in the province of Pará [on the Lower Amazonas], in some measure under my direction. Since that time he has

gathered a very extensive collection of insects, numbering, as he assures me, many thousands of species. This collection is now owned by Mr. Smith, and it is of so great value that I feel it my duty to call the attention of your Excellency to the matter, suggesting that it may be advisable to take steps toward securing at least a complete set of the species for the National Museum.

In accordance with the request of your Excellency, I accepted the Directorship of the geological section of the National Museum. After inaugurating the plan and arranging the work for my assistant during my absence, I propose to leave the city to continue my studies in the north.

My prospective journey is as follows: to leave Bahia for the diamond fields, and after examining these to proceed as far as the Rio Sao Francisco, to a point not yet determined. I intend to visit the watershed between the Sao Francisco and Tocantins rivers and to determine its character, afterward descending the Sao Francisco to the vicinity of the rapids of Paulo Affonso. From thence I expect to make a trip to the Serra de Araripe, and then to visit the locality of fossil fishes to examine the Serra de Ybiapaba, striking the sea coast probably at Ceará.

After making this expedition and reviewing the work of the assistants, who will be left along the coast in the provinces of Bahia, Sergipe and Alagoas, I ought to have a somewhat clear idea of the general geology of the northeastern portion of the empire, a region concerning which we have now very little information. This journey will probably occupy about four months. At the close of the exploration I propose to return to Rio de Janeiro with the members of the Commission to arrange and describe the collections and to prepare a report *in extenso* upon all the results obtained by the Commission with descriptions and engravings of a large number of Brazilian fossils.

Addendum by the Translator.

A letter received from Professor Hartt, bearing date, Rio de Janeiro, March 25, 1876, gives some particulars concerning the work accomplished since the writing of the foregoing report. He states that Messrs. Derby and Rathbun have met with most excellent results at Bahia, while Dr. Freitas and Mr. Branner have made yet another very large collection of Cretaceous fossils from the Maröim region. Mr. H. H. Smith had also done characteristic work upon the Amazonas, amassing extended and valuable collections. Professor Hartt himself was about ready to start for the interior.

By the same mail a letter was received from Mr. O. A. Derby, dated Santo Amaro, near Bahia, March 26, 1876. He writes: "We have found some rich deposits of Cretaceous fishes and

reptiles in this vicinity and are working them up with care. I do not know as yet what we have, but am certain of several species of Crocodiles and think we have *Iguanodon.* * * * Branner reports quantities of fine Cretaceous fossils from the Province of Sergipe, where he is now." * * * * * * * *

"We are now engaged in an exploration of the bay [Bahia de Todos os Santos] and are in a little town four hours by steam from the city [Bahia]. The geology of this vicinity is mainly Cretaceous and Tertiary and quite interesting, though one should have a dozen pairs of eyes to study it. Sections are hard to find and when found more difficult to understand properly. The rock is much decomposed and about a dozen different things present almost the same appearance when in a state of decomposition."

"I have visited a diamond locality. * * * They occur in gravel which is either late Tertiary or modern."

A collection of Brazilian auriferous ores, Professor Hartt writes, will be exhibited at the Centennial Exposition in Philadelphia. The friends of the Professor will be pleased to learn that he has removed with his family to the mountains back of Rio, where all are safe from the ravages of the yellow fever.

Letters for the members of the Commission should be sent enclosed to Major O. C. James, Secretario do Commissao Geologica, Caixa no Correio No. 126, Rio de Janeiro, Brazil, to whom all business connected with the survey may be entrusted. Questions which can be answered by the undersigned will receive due attention. THEO. B. COMSTOCK.

Ithaca, N. Y., May 5, 1876.

ART. LXIV.—*Notice of the Meteoric Stone of Waconda, Mitchel County, Kansas;* by CHARLES UPHAM SHEPARD, Sr., Massachusetts Professor of Natural History in Amherst College.

FOR my first knowledge of the meteorite of Waconda, Kansas, I am indebted to Dr. George W. Chapman of that place. This gentleman wrote me on the subject during my absence from the country the past summer, and it was not until lately that the correspondence was renewed which has led to the information now afforded. From his letters and a few grams of the stone transmitted by post, I am enabled to give the following partial description,—reserving a fuller account until my return to the north, when I expect to receive the large mass from which the fragments sent were detached.

The stone was found two years since, lying above ground, in the grass, upon the slope of a ravine, at the distance of two

miles from the village of Waconda. Many pieces were then broken from the mass, leaving about one-half, whose present weight is fifty-eight pounds, half of which is still covered by the original crust. The specimens transmitted show a freshness equal to that of any newly fallen stone, although they came from the immediate surface,—a circumstance obviously pointing to the recentness of the fall. I have known instances where stones exposed only a few weeks to the weather have suffered a decided oxidation, whereas no such change seems to have occurred in this case.

Its cohesion is about that of the average among meteoric stones. In this respect, as well as shade of color, it corresponds very nearly to the Searsport (Me.) stone, of May 21, 1871; but in structure it differs by being less oolitic. Indeed, it is only obscurely so at all,—the individuals that are distinct being rather granular, often with well-marked angles, some of which suggest the species augite; others, those of forsterite (variety boltonite). There is considerable amorphous whitish matter interposed among the grains (in which they may be said to be imbedded), which is doubtless a mixture of minerals, and may consist of chladnite with some one or more of the feldspars. The chamasite (nickelic iron) is present in thickly scattered, very minute, rounded, lustrous grains, requiring for the most part the use of a lens for their discovery; while the troilite (magnetic pyrites) is now and then seen in considerable grains, or ovoidal aggregations of imperfect crystals. The crust is rather thicker than usual, of a dull iron-black color, with a slight tinge of brown, and much crumpled or reticulated. The specific gravity of a fragment weighing 4·35 grams (of which two-fifths were covered by crust) is 3·810; that of a fragment without crust, weighing 3·57 grams, is 3·58.

By mechanical analysis the stone gave 5·66 per cent of chamasite, and 1·34 per cent of troilite. The earthy portion was rather more than one-half decomposed by aqua regia, the soluble portion, after the separation of the silica, giving magnesia, and protoxide of iron (with a little lime) in the usual proportions of chrysolite. The matter not attacked by acids probably belongs to augite, some feldspathic species, and chladnite.

There exists a rumor that a second stone has been found, twelve miles distant from the first; but it lacks confirmation.

It is very likely that the exact date of this meteoric fall will yet be ascertained, inasmuch as it must have taken place very lately, and, without doubt, was attended with a notable report.

Charleston, S. Car., March 16, 1876.

ART. LXV.—*Paleozoic subdivisions on the 40th Parallel;* by CLARENCE KING.

THE geological exploration of the fortieth parallel has covered an east and west section of the Cordilleras from the 104th to the 120th meridian, or from the east base of the Rocky Mountains to the eastern boundary of California, along the fortieth and forty-first parallels. The belt of territory under examination is a little over one hundred miles from north to south. Over the greater part of this area bodies of Paleozoic rocks are observed at intervals. A considerable study of these more or less detached exposures, together with the final determination of a large collection of molluscan fossils, has rendered it possible for us to correlate the various members of the series, and construct with considerable precision a complete Paleozoic section. It is the object of this paper to announce the stratigraphical divisions established in the field, and their relation to the Paleozoic subdivisions as established in New York and in the Mississippi basin.

It may be well to remark that along our eastern boundary, in the region of the Rocky Mountains, the entire Paleozoic series—including Coal-measure beds and strata bearing Potsdam fossils—are embraced within a section from 900 to 1200 feet, the whole entirely conformable and resting discordantly upon an Archæan foundation. In passing westward the series rapidly expands from 1,000 to 32,000 feet. Lithologically, divisions which were lost in the narrow Rocky Mountain Paleozoic zone are established with great volume and persistency over wide areas in Utah and middle Nevada. Finally, in the neighborhood of Battle Mountain, at longitude about 117° 25′, an Archæan land-mass rose to the west of the Paleozoic ocean, interrupting farther continuance in that direction.

The region of the Rocky Mountains represented Archæan islands and shallows, around and over which the sparing sediments were deposited, while toward the westward the general contour of the Paleozoic ocean deepened over a broad basin, which probably continued to a great depth quite against the western shore in longitude 117° 30′. To the southward, from the well-known observations of Dr. Newberry and others, it is evident that this Paleozoic sea very perceptibly shallowed. The northern configuration of the bottom and the depth of the Paleozoic series in at present unknown. It is a striking fact, that wherever, within the limits of this exploration, exposures are made,—and they are very frequent,—from the Primordial to the summit of the Coal-measures, there is never the slightest unconformity between the various members of the series. The

key to the subdivision of the whole Paleozoic is obtained in the Wahsatch Range, where I have observed a single section of about 30,000 feet of conformable rocks extending from the Permo-carboniferous strata, conformably underlying the red sandstones of the Trias, down to low exposures of the Cambrian.

Ignoring such minor subdivisions as we find to be very variable and local, and describing only such as are observed to be persistent and widespread, I will note in their order from the base of the Cambrian upward the important stratigraphical subdivisions, with their position in the New York scheme.

The lowest member of the series consists of a group which rests non-conformably upon the Archæan, and consists of three prominent members: the lowest is a series of siliceous schists and argillites, best exposed at the mouth of Big Cottonwood Cañon, in the Wahsatch Range, and having a total thickness of from 800 to 1,000 feet; over this is a series of quartzite and quartzofeldsitic strata, having limited beds of slate interspersed through it and containing near the top some dark micaceous zones, the whole reaching in Cottonwood Cañon a thickness of over 12,000 feet: the uppermost member is a narrow zone of variable argillites, calcareous shales, and thin, slightly siliceous limestones having in the Wahsatch an extreme thickness of seventy-five feet. The shaley zone and the accompanying slates carry fossils of well-defined Primordial types, but the quartzite and the deep-lying slates have not yet yielded any organic forms. We have therefore in the Wahsatch a series of 12,000 feet, of which the thin summit member carries Primordial fossils, and the vast underlying series is thus far barren. Comparing the quartzites and argillites with those of the Cambrian section in Wales, the likeness is too great to pass unnoticed, and in view of the enormous developments of these low-lying rocks, as compared with the Silurian lying above the Primordial horizon, I have determined to draw a line at the upper limits of the Primordial period to include the uppermost members of the Potsdam epoch, and to consider the whole underlying conformable series as Cambrian down to the point of their non-conformity with the Archæan. In the extreme east of our work, in the region of the Rocky Mountains, the Cambrian formation is of variable thickness and nowhere reaches an exposure of over 100 feet. In middle Nevada the uppermost zone of the Cambrian, equivalent to the calcareous and argillaceous shales of the Wahsatch, is an immense body of dark limestones at least 3,000 feet in thickness carrying Primordial fossils throughout; the downward continuation of the series being there entirely hidden by the overlying Quaternary desert. The fossils obtained by our survey from the Cambrian series are as follows:

Lingulepis Mær, n. sp.
" ? minuta, n. sp.
Obolella discoidea, n. sp.
" sp?
Kutorgina minutissima, n. sp.
Paradoxides? Nevadensis *Meek.*
Conocephalites (Ptychoparia) Kingi *Meek.*
Conocephalites (Pterocephalus) laticeps, n. sp.
Crepicephalus (Loganellus) Anytus, n. sp.
" " Haguei, n. sp.
" " granulosus, n. sp.
" " maculosus, n. sp.
" " nitidus, n. sp.
Crepicephalus (Loganellus) simulator, n. sp.
" (Loganellus) unisulcatus, n. sp.
" (Bathyurus?) angulatus, n. sp.
Chariocephalus tumifrons, n. sp.
Ptychaspis pustulosus, n. sp.
Dicellocephalus bilobatus, n. sp.
" flabellifer, n. sp.
" multicinctus, n. sp.
Agnostus communis, n. sp.
neon, n. sp.
" prolongus, n. sp.
" tumidosus, n. sp.

Conformably overlying the summit shales of the Cambrian is a body of limestone, which in the Wahsatch has a maximum development of 2,000 feet, thinning out along the southern part of our belt of country in the region of the Little Cottonwood cañon of the Wahsatch to 1,000 feet. This group, to which we have given the name of the Ute Limestone. has thus far yielded only fossils of the Quebec group; but none have been obtained from its immediate summit or base. In western Nevada the calcareous shales of the Potsdam and the limestone of the Quebec have enormously thickened, and the whole body of Silurian and calcareous upper Primordial represent from 4,000 to 5,000 feet of continuous limestone, in which were found fossils of the Lower Helderberg, Niagara, Quebec and Primordial. In the Wahsatch it is certain that the Ute limestone is, with the exception of possibly a few thin members at the top and at the extreme bottom constituting an insignificant fraction of the whole zone, altogether of Quebec; while in the middle of Nevada, in the region of White Pine, Robert's Peak and the Piñon Mountains, more than half of the heavy body of limestone is Primordial, a very limited amount is Quebec, and a very large portion of the upper part of the series—exact horizons being yet undetermined—is occupied by the Niagara and Lower Helderberg. The Quebec is represented by the following fossils:

Lingulepis Ella, n. sp.
" or Lingula, sp.?
Obolella, sp?
Kutorgina, sp. undeterminable.
Orthis Pogonipensis, n. sp.
Leptæna melita, n. sp.
Strophomena nemia, n. sp.
Porambonites obscurus, n. sp.
Rhynchonella, sp.? fragments only.
Ophileta complanata, var nana *Meek.*
Euomphalus (Raphistoma) rotuliformis *Meek.*
Euomphalus (Raphistoma) trochiscus *Meek.*
Raphistoma acuta, n. sp.
Maclurea minima, n. sp.
Cyrtolites sinuatus, n. sp.
Fusispira compacta, n. sp.
Conocephalites subcoronatus, n. sp.
Crepicephalus (Loganellus) quadrans, n. sp.
Dicellocephalus gothicus, n. sp.
" quadriceps, n. sp.
" Wahsatchensis, n. sp.
Bathyurus Pogonipensis, n. sp.
Ceraurus? sp.
Ogygia paraboloidalis, n. sp.
" producta, n. sp.

The Niagara furnishes the following:

Cladopora sp. (resembles C. seriata *Hall*).
Orthis (resembling O. hybrida, *Dal.*, but of larger size.
Atrypa reticularis *L.*
Atrypa resembles *A.* nodostriata, *Hall.*
Illaenus, sp. undet.

The following fossils from the Lower Helderberg horizon were found:

Favosites Helderbergia *Hall.*
Diphyphyllum, n. sp.?
Campophyllum (impressions only).
Crinoidal columns.
Small branching Bryozoans, too indistinct for generic determination.
Crania, sp. undet.
Orthis multistriata *Hall.*
" new sp., (resemb. young of O. oblata *Hall*).
Strophodonta punctulifera *Con.*? fragments only.
Spirifera Vanuxemi *Hall.*
Trematospira?
Collospira, new sp. (allied to C. imbricata *Hall*).
Atrypa reticularis *L.*
Rhynchonella, sp. undet.
Pentamerus galeatus *Dal.* (frag. only).
Cryptonella, sp.? (fragments only).

Directly overlying the Ute limestone is a quartzite which is distinctly developed in the Wahsatch Mountains, varying from 1,000 to 1,600 feet thick. It is usually white or pale green, very fine-grained and slightly schistose toward the top, and contains occasional zones of conglomerate consisting of remarkably smooth quartz pebbles in a fine siliceous matrix. From its characteristic development in Ogden cañon we have called it the Ogden quartzite. It is again met with in western Nevada, where it has a thickness of 700 or 800 feet. This body of siliceous material is sometimes altogether wanting, its place being taken by limestone, the Ute and Wahsatch limestones forming one continuous body, siliceous impurities marking the horizon of the Ogden. In the Wahsatch the Ogden quartzite is overlaid by a limestone of very great thickness, to which we have given the name of the Wahsatch limestone, and whose lowermost fossils in the Wahsatch are Upper Helderberg. In western Nevada also the Ogden quartzite is seen between the upper and lower Helderberg horizons. We have included it provisionally within the Devonian age, considering it the probable equivalent of the Schoharie and Cauda-galli grits.

Next above the Ogden quartzite, as just mentioned, lies the Wahsatch limestone, a body reaching 7,000 feet in thickness in the Wahsatch and over 8,000 in middle Nevada. Although varying slightly in the purity of the material and constantly in its physical aspect, it is nevertheless a single limestone series. The lower 1,200 or 1,400 feet are embraced within the Devonian, and characterized by fossils of the Upper Helderberg and Chemung group, and in a single instance a group which would seem to have the facies of both the Upper and Lower Helderberg. If in the lowermost members there is a mingling of Silurian forms, as may possibly hereafter be proven, it will then be necessary to move the Silurian line higher, so as to include the Ogden

quartzite; but the present evidence would seem to restrict the Lower Helderberg to the region below the Ogden quartzite.

From the horizon of the Upper Helderberg were obtained the following:

Alveolites multiseptatus *Meek.*
Cladopora prolifica *H. & W.*
Acervularia pentagona *Goldf., Meek.*
Smithia Hennahii *Lourd., Meek.*
Diphyphyllum fasciculum *Meek.*
Ptychophyllum ? infundibulum *Meek.*
Naticopsis, sp. undet.
Orthoceras Kingii *Meek.*

From the upper members of the Devonian, ranging from the Upper Helderberg to the Chemung inclusive, there were obtained:

Favosites polymorpha *Goldf., Meek.*
Syringopora Macleuri ? *Bill.*
Smithia Hennahii *Lourd., Meek.*
Cyathophyllum Palmeri *Meek.*
Strophodonta canace *H. & W.*
Productus subaculeatus *Murch.*
Spirifera alba-pinensis, n. sp.
" argentaria *Meek*, (very closely allied to S. zigzag *Hall*).
Spirifera Engelmani *Meek.*
Atrypa reticularis *L.*
Rhynchonella Emmonsi, n. sp.
Pentamerus, sp ?
Cryptonella, sp.?=Rensellaeria ? sp. *Meek.*
Paracyclas peroccidens, n. sp.
Pterinea, sp.?
Pleurotomaria, sp. undet.
Isonema, sp. ?
Bellerophon neleus, n. sp.
Orthoceras, sp. ?

In a single instance, namely, that at White Pine, the Chemung is overlaid by black shales, the probable equivalent of the Genesee group, from which are collected the following:

Leiorhynchus quadricostatus *Hall*= Rhynch. (*Leiorhynchus*) papyraceus *Meek.*
Aviculopecten catactus *Meek.*
Nuculites triangulatus, n. sp.
Linulicardia fragosa = Posidonomya fragosa *Meek.*

From our present knowledge it would seem that the lower 1,200 or 1,400 feet of the Wahsatch limestone is strictly Devonian. The Genesee and the Chemung are followed by beds carrying forms having a close resemblance to the Waverly group, but which are considered by Messrs. Hall and Whitfield as closely allied to the Upper Devonian. They consist of the following species:

Michelinia sp.?
Streptorhynchus equivalvis *Hall.*
" inflatus *H. & W.*
Strophomena rhomboidalis *Whal.*
Chonetes Loganensis, n. sp.
Productus, sp.? (fragments only).
Spirifera centronata *Winch.*
" alba-pinensis, n. sp.
Athyris Claytoni, n. sp.
Athyris planosulcata ? *Phillips.*
Rhynchonella pustulosa? *White.*
Terebratula Utah, n. sp.
Euomphalus (Straparollus) Utahensis, n. sp.
Euomphalus latus *var.* laxus *White.*
" (Straparollus) Ophirensis n. sp.
Proetus peroccidens, n. sp.
" Loganensis, n. sp.

The thickness of the Waverly series is not definitely known, since there is quite a gap of barren limestone between it and the next fossiliferous zone. Not far, however, above the Waverly, especially as shown in the Oquirrh Range and White Pine, occur fossils of the true Sub-carboniferous, such as:

Zaphrentis eccentrica *Meek.*
Fenestella, sp. ?
Polypora, sp. ?
Glauconome, sp. ?
Orthis resupinata *Martin?*
Productus lævicostatus *White?*
" semireticulatus *Mart.*
" elegans *N. & P.?*
Productus Flemingi, *var.* Burlingtonensis *Hall.*
Spirifera striata *Mart.*
" setigera *Hall.*
" Keokuk *Hall.*
" sp.? resembles S. imbrex *Hall.*
Athyris subquadrata *Hall.*

From the evidence in the Oquirrh Range it would seem that the Sub-carboniferous and Waverly together cannot be less than 1,000 feet thick. Through the remainder of the Wahsatch limestone, up to its very summit—a thickness of at least 4,000 feet above the Sub-carboniferous—are found at intervals beds carrying distinct Coal-measure forms. This immense body of limestone therefore, represents 4,000 to 4,500 feet of Coal-measures, 1,000 to 1,200 feet of Sub-carboniferous and Waverly, and 1,000 to 1,400 feet of Devonian, all these figures varying slightly according to the general expansion or contraction of the Wahsatch limestone as a whole in different localities.

Next in the series above the Wahsatch limestones occurs a very remarkable bed of siliceous material, which we have named the Weber quartzite from a typical occurrence in the Weber cañon of the Wahsatch Range. Here, conformably overlying the limestone, is a body of quartzite about 6,000 feet in thickness, having a few red sandstones at the base, and occasional limited fine beds of shale interspersed at three or four different horizons through the body, and varied to a considerable extent by thin sheets of conglomerate and rounded quartz pebbles. It has never in this locality yielded any fossils; but its reference to the middle of the Coal-measures is rendered absolutely certain by the collection of great numbers of different Coal-measure fossils from the Wahsatch limestone below and from an overlying body of limestone to be described later. In the cañon of the Weber, this Weber quartzite has a minimum thickness. In the Oquirrh it has been estimated to be 9,000 or 10,000 feet; and unless we have made some errors in the assignments of horizons in western Nevada, it there reaches an even larger figure. To this member of the series we have referred the great body of sandstones with intercalated shales and conglomerates which form the body of the Uinta Range, and there display a thickness of certainly over 10,000 feet, and according to Major Powell, a much greater thickness. The evidence on which this is referred will be detailed in the forthcoming geological report of this exploration. The Weber quartzite is exceedingly variable in its thickness and mechanical condition. For the most part it represents a true quartzite, but here and there at various localities it is less altered and is merely a series of coarse granular sandstones. At several places in the Wahsatch this body of quartzite is exposed between the two Coal-

measure limestones, where there can be no doubt of its true stratigraphieal relations.

Conformably overlying this is a body of about 2,000 to 2,500 feet of limestones, chert-beds, calcareous and argillaceous shales, and some beds of calcareous sandstones and arenaceous limestones, the whole constituting a very variable series, and carrying from the bottom to the top distinct Coal-measure forms. In middle and eastern Nevada the shales and arenaceous beds are wanting, and the whole series is a continuous body of limestone.

In the broken and dislocated exposures of the desert country of Nevada there are many outcrops of limestone disconnected from other formations and only referable by their fossils to the Coal-measures. In such cases it is sometimes impossible to determine whether the body should be strictly referred to the Upper Coal-measures or to the Coal-measure part of the Wahsatch limestone. In consequence of this uncertainty, it is impossible at present to say what species are common to both Coal-measure limestones and to group those which are restricted to the two different horizons. From localities where the data is complete, it is evident that both limestones have many species in common. The combined list of the two is too extensive to be published here but will be found in full in the Paleozoic chapters of our reports.

Overlying the true Upper Coal-measures is a variable body of argillaceous and calcareous shales and mud rocks, with limited beds of limestone and sandstone, containing many ripple marks and unquestionably a deposit of very shallow water. It is composed altogether of fine silted material and contains forms which have been referred unhesitatingly by Meek, and Hall and Whitfield to the Permo-Carboniferous. This series is extremely variable and reaches a maximum of 500 feet. While through the Upper Coal-measures there is more or less evidence in the country east of the Wahsatch of a progressive shallowing, there is a decided difference between the Coal-measure proper and the Permo-Carboniferous. The two are apparently quite conformable, yet at the same time a very great change of condition has taken place and it is possible that subsequent study will show a slight discordance of position. If so, the extent of the disturbance of the pre-Permian members has been very slight east of the Wahsatch, while to the west of that range the Permian is wanting.

The following are some of the characteristic fossils :

Aviculopecten curtocardinales, n. sp.
" McCoyi *Meek.*
" sp., *Meek*, (Pal. Up. Mo., plate 2, fig. 10).
Aviculopecten occidaneus *Meek.*
" parvulus, sp. n.
" sp.? resembling Pecten Clevelandicus *Swallow.*
Aviculopecten Weberensis, sp. n.
Eumicrotis Hawni *M. & H.*
" sp. undet.
Myalina permiana *Meek.*
Myacites Weberensis *Meek.*
" aviculoides *Meek.*
" inconspicuus *Meek.*
Schizodus, sp.,=S. ovata *Meek.*

From the immense thickness developed in central Utah, the Paleozoic series, there 30,000 feet thick, thins toward the east until as before stated, in the region of the Laramie Hills, it is compressed into 1,200 feet. From the observations of Newberry, and the later accounts of Gilbert, Powell and Marvine, it is clear that it also shallows toward the south, and the observations of the Carboniferous in California would indicate thinning in that direction.

The Archæan body spoken of in western Nevada may or may not have had a continental significance. It would seem, however, from the relations of the Carboniferous in the Blue Mountains of Oregon and Bass' Range in California, that, if a continental mass, it possessed deep westward bays in which the Paleozoic sediments were deposited. It is, however, probable that the Archæan body was only a mountainous region of no very great east and west development, and that the Paleozoic sediments were deposited around it to the north and south.

While as yet no non-conformity has been observed in the whole series from the base of the Cambrian up, there is in middle Nevada an evidence of shallow water and the accumulation of plant-bearing earthy coal beds in the upper part of the Wahsatch limestone. When the detailed stratigraphy to the south of our field comes to be worked out, it is possible that a local uplift will be found near the close of the deposition of the Wahsatch limestone. But otherwise throughout the whole extent we have no indication of a non-conformity. On the contrary, there seems to have been a continuous undisturbed deposition varying between siliceous and calcareous sediments in which the lines of these two types of material have been sharply drawn in a deep oceanic basin over the greater part of the area of Utah and Nevada, while toward the shallow shore in the region of the Rocky Mountains the deposit was more irregularly mixed. Aside from the intimation of a local shallowing at the close of the Wahsatch limestone in western Nevada, the evidences are all of deep-water deposits till near the close of the Upper Coal-measure series, when ripple-marked shales make their appearance, and the Permian depositions thereafter seem all to be of a shoal-water character.

ART. LXVI.—*A Nebula-photometer;* by E. C. PICKERING. (From a letter to the editors, dated Boston, April 5, 1876).

AN examination of the article in the May number of this Journal on the changes on the Nebula M. 17 shows the desirability of accurate photometric measurements of these bodies. I wish therefore to make known the following nebula-photometer in

Page 482, line 5 from top, for Powell read *Howell*.

hopes that some one having the use of a telescope of sufficient size may undertake such measurements. A plate ruled with squares is inserted in the eye-piece of an equatorial telescope with a minute circle of collodion near the center as in the photometer of Dove. It is illuminated in front by the nebula, and behind by a plate of glass inclined at an angle of 45° which reflects the light of a lamp placed on one side of the eye-piece. The light may be varied by two crossed Nicol's prisms, by passing the light through a slit whose width may be varied and measured, or in other ways. To measure the brightness of a nebula the various portions are brought in succession into the center of the field and the light varied until the spot disappears. The exact position of each point is found by observing the various positions of any star in the field with regard to the squares. The real motion of the photometer is thus found from the apparent motion of the star. A contour map may then be constructed showing the brightness of the various portions, and would soon show any marked changes in the light of the various parts. The light of the adjacent sky must be similarly measured and subtracted from all the readings. The brightness may be compared with that of any star by throwing the latter out of focus until its disk attains a given size, and a star photometer is thus obtained. Observations on a comet, with contours showing its brightness on various days, would be both interesting and valuable The brightness of different portions of the moon could be measured by slightly modifying this photometer. By using a very low power the light of an aurora, of the zodiacal light or of different portions of the sky could be similarly measured. For very faint objects it might be better to insert a diaphragm in the eye-piece having an aperture but little larger than the collodion film, thus giving a dark background. Positions could then be determined by the finder or by moving the entire eye-piece by micrometer screws.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Hydrocellulose.*—In some of the processes in the arts in which cellulose is used, as in paper-making, this substance undergoes a transformation by which it is rendered friable. Ainié Girard has investigated the matter, and finds that this change is owing to the assumption of a molecule of water by the cellulose to form a new body of the composition, $C_{12}H_{22}O_{11}$, to which he gives the name of hydrocellulose. To prepare it, some form of purified cellulose, such as carded cotton, is placed in sulphuric acid of 45° B. in the cold for twelve hours. It is then well washed, pressed and dried. After it is dry, its fibrous character is destroyed by pressure; rubbing between the fingers converting it into a white

powder. Girard explains in this way the brittleness of certain papers bleached with chloride of lime.—*C. R.*, lxxxi, 1105, Dec. 1875.

G. F. B.

2. *On the Decomposition of Stearic Acid by distillation under Pressure.*—Under the direction of Professor Thorpe, JOHNSTON has submitted stearic acid to distillation under pressure, with a view to determine the decomposition products. A copper tube was employed for this purpose, bent twice at right angles. At the second bend from the end, which served as the retort, was an elongation of the tube serving as a receiver. The end of the tube was provided with a stopcock to allow the gases to escape. The stearic acid was heated, allowed to distill over, then run back into the retort, again distilled over, and so on until the acid was completely decomposed. The liquid products were collected and examined. They proved to be hydrocarbons of the marsh gas and olefine series exclusively. The gases resulting were similar, with the addition of water vapor and carbon dioxide.—*J. Chem. Soc.*, II, xiv, 8, Jan., 1876.

G. F. B.

3. *On Liquid Carbon Dioxide in mineral cavities.* — On heating a microscopic slide of quartz containing fluid cavities only to a moderate temperature, HARTLEY was surprised to find that the liquid, previously perfectly visible under the microscope, had disappeared. On cooling, the liquid reappeared accompanied by a sort of flickering movement within the cavity. Experiments on fluid cavities in various minerals made by Brewster in 1823, showed that the liquids all disappeared below 88° F., that their expansion between 50° and 80° F. was 32 times that of water, and their index of refraction 1·2946 in topaz and 1·2106 in amethyst. From these results Simmler, and later, Sorby and Butler concluded that the liquid must be carbon dioxide. The author sought carefully to determine the critical point of the liquid, which he did by immersing the slide in water of known temperature, removing, wiping hastily, and examining. As a result, it appeared that the critical point lay between 30·75° and 31° C., that point for pure carbon dioxide having been fixed by Andrews at 30·92° C. In further corroboration of this view is the fact that when water was also present in the same cavity, the other liquid floated on it; the density of carbon dioxide being 0·83 at 0° and 0·6 at 30°. Moreover, Geissler has shown the presence of this gas in quartz by its spectrum in a vacuum tube in which the quartz was broken. In explanation of the formation of these fluid cavities, the author supposes the silica in hot solution to have come in contact with a limestone under pressure, setting free carbon dioxide which being enclosed in the crystal cavities along with water would on cooling condense to a liquid.—*J. Chem. Soc.*, xxix, 137, February, 1876. G. F. B.

4. *Decomposition of Alcohol by Aluminum and its Iodide.*—GLADSTONE and TRIBE have continued their researches on the action of aluminum in presence of its haloid salts upon organic

bodies. Alcohol for example, which may be boiled for hours with metallic aluminum without action, evolves hydrogen at once when aluminum iodide is added to the mixture, and in amonnt precisely equal to that theoretically obtainable from the aluminum. The residue of the reaction consisted of aluminum ethylate mixed with some iodo-ethylate. The former body distilled over above 275° C., but suffered partial decomposition. Under diminished pressure, a yellowish white solid collected in the receiver, which fused at 115° and boiled about the boiling point of mercury. Analysis showed it to be aluminum ethylate. The same action was observed with amyl alcohol, and with bromide in place of iodide.—*J. Chem. Soc.*, clviii, 158, Feb., 1876. G. F. B.

5. *New Method for producing Condensed Hydrocarbons.*—Watson Smith, having observed that naphthalene passed through a red hot tube, loses hydrogen and produces iso-dinaphthyl, sought to increase the yield of this substance by heating the naphthalene vapor with that of some volatile and easily reducible metallic chloride, the chlorine of which should help to remove the hydrogen. A mixture of naphthalene and antimonous chloride vapors passed through a red hot tube filled with pumice, gave an abundant yield of iso-dinaphthyl. The reaction is—

$$(C_{10}H_8)_6+(SbCl_3)_2=Sb_2+(HCl)_6+\begin{pmatrix}C_{10}H_7\\ \vdots\\ C_{10}H_7\end{pmatrix}_3$$

The author thinks the reaction general.—*Ber. Berl. Chem. Ges.*, ix, 467, April, 1876. G. F. B.

6. *On Manganese Boride and on the Function of Manganese in Iron Metallurgy.*—Troost and Hautefeuille have produced a definite manganese boride simply by heating boric acid in a carbon crucible with manganese carbide. Small dark violet crystals were obtained which afforded on analysis the formula MnBo, containing 27 per cent of boron. When free from an excess of manganese, it dissolves in acids, disengaging hydrogen. Water is not decomposed by it at 100°. Mercuric chloride when moist transforms it at once into manganese chloride, boric, and chlorhydric acids. In this reaction, each gram evolves 1697 calories; while its elements taken free evolve 4184; the difference 2487 calories represents the heat set free by the manganese and the boron in combining. Hence the compound is an energetic one. Iron borides too are stable, unlike the iron carbides and silicides. The authors conclude from their researches that the important part which manganese plays in the metallurgy of iron is due (1) to the formation of compounds which evolve in their production a greater amount of heat than that set free by the corresponding compounds of iron; and (2) to the facility with which these compounds form slags, since in oxidizing they evolve more heat than those which contain the same quantity of iron; especially when, as is the case, they exist in presence of a large excess of metal.—*C. R.*, lxxxi, 1263, Dec., 1875. G. F. B.

7. *On the Occurrence of Platinum, Palladium, and Selenium in Silver coins.*—In a letter to Wöhler, RÖSSLER, of the Frankfort parting office, gives some facts of interest relative to the work done in that establishment. During the last year over 400,000 pounds of silver and 5,000 pounds of gold were parted. The silver is purified by crystallization as sulphate and subsequent reduction to the metallic state by iron turnings. The gold is precipitated from its solution in aqua regia by ferrous chloride and melted in gas furnaces; being obtained 1000 fine in this way. Fine silver, especially that obtained from old coins, contains gold averaging about one-thousandth. It also contains both platinum and palladium, the latter sometimes in so large a quantity that its solution in nitric acid is dark yellow. The silver from Commern and Mechernich in the Eifel showed 0·0058 per cent platinum and 0·0053 per cent palladium. In the last year, the office has obtained from the 500,000 pounds of crude silver worked over, twelve pounds of platinum and two pounds of palladium. To obtain these metals, the solution, from which the gold has been precipitated by ferrous chloride, is reduced again by iron turnings, whereby all the other metals present are precipitated as a black sediment. This is freed from copper by the iron chloride, the residue is dissolved in aqua regia, the traces of remaining gold are removed, the platinum is thrown down by ammonium chloride and the palladium by ammonia and hydrochloric acid. In this way selenium was discovered in this deposit. Since then the sediment is fused with soda and charcoal before treating it with aqua regia; several pounds of selenium a year being obtained from this source. The selenium forms an interesting compound with palladium, which is obtained in hard brilliant plates when the regulus obtained as above is dissolved. These plates are not soluble in nitric acid, nor, when platinum is present, in aqua regia; but on ignition they evolve selenium and are then soluble. They are composed of equal atoms of palladium and selenium and resemble the iridosmine scales very closely, being isomorphous with them.—*Liebig's Ann.*, clxxx, 240, Feb., 1876. G. F. B.

8. *On the Conversion of Olefines into the corresponding Alcohols.*—The considerable similarity between the heptylene obtained from pentamethyl-ethol and the terpenes led BOUTLEROW to attempt the direct synthesis of the alcohol from the olefine by direct union with water, just as the hydrate of terpin is formed. The heptylene was sealed in a tube with water containing a little nitric acid and alcohol. After a few weeks the heptylene had disappeared and had been replaced by the characteristic crystals of pentamethyl-ethol. Liquid isobutylene was then subjected to a similar treatment and with a similar result; trimethyl-carbinol was produced. Sulphuric acid was found to act upon isobutylene in the same way. This olefine, sealed in a tube with double its volume of a mixture of equal parts concentrated sulphuric acid and water, disappeared in the course of two days, and yielded

trimethylcarbinol. Pseudobutylene, isomeric with the former, suffers a similar change but much more slowly.—*Liebig's Ann.*, clxxx, 245, Feb., 1876. G. F. B.

9. *On the Trimethylbenzols of Coal tar Oil and their Separation from each other.*—Jacobsen has examined very carefully the trimethylbenzols obtainable from coal tar and has shown that only two, mesitylene and pseudocumol are present therein, the third one which theory points out as possible, not existing in the oil at all. Pseudocumol forms only a single sulpho-acid with sulphuric acid, the salt supposed formerly by the author to be isocumolsulphate of barium being a well characterized double salt of mesitylene-sulphate and pseudo-cumol-sulphate. The two trimethylbenzols found separated readily by converting them into the amides of the sulpho-acids, by obtaining first the chlorides by the action of phosphoric chloride and then the amide by the action of ammonia upon this. By crystallization from alcohol, the two substances, mesitylene-sulphamide and pseudocumolsulphamide, are easily and completely separated, the former being far more soluble. On treating the pure amides with hydrochloric acid, the hydrocarbons were regenerated.—*Ber. Berl. Chem. Ges.*, ix, 256, Feb., 1876. G. F. B.

10. *On the Detection of Phloroglucin and Nitrites.*—When very dilute solutions of phloroglucin and of toluidine or aniline nitrate are mixed and a few drops of a solution of potassium nitrite is added, the liquid, at first clear, becomes turbid and brownish-yellow, then orange, and deposits a cinnabar-red precipitate. Weselsky, who discovered this reaction, proposes it as a test for phloroglucin and nitrites. One c.c. of a solution, containing 0·0005 gram phloroglucin was mixed with one c.c. of a solution of toluidine nitrate saturated at ordinary temperatures, diluted to 50 c.c. with water and treated with one c.c. of a solution containing 0·001 gram potassium nitrite. In 15 minutes the solution became yellow and in three hours the cinnabar precipitate was obtained. Similar reactions are obtained with aqueous solutions of maclurin and catechin, and decoctions of fustic and hops, in place of phloroglucin.—*Ber. Berl. Chem. Ges.*, ix, 216, Feb., 1876. G. F. B.

11. *On the Succinic acid obtained from Active Tartaric acid.*—Pasteur announced some time ago the existence of an optically active succinic acid, and Kekulé showed that the succinic acid derived from active malic acid was itself inactive. Bremer and Van't Hoff, deeming the existence of such an active succinic acid extremely improbable, since its molecule contains no asymmetrical carbon atom, have examined the acid which is produced along with dextro-malic acid, by the reduction of dextro-tartaric acid. The acid in question proved to be absolutely inactive and to agree in all respects with ordinary succinic acid. Hence we have: (1) Dextro-tartaric acid, $\underline{C}O_2H.\underline{C}(OH).CH(OH).CO_2H$, containing two asymmetrical carbon atoms and rotating the polarized plane $(\alpha)=6°·6$; (2) Dextro-malic acid, $CO_2H.\underline{C}H(OH).CH_2.$

CO_2H, containing one asymmetrical carbon atom and rotating $(\alpha)=3°{\cdot}3$; and (3) Succinic acid $CO_2H.CH_2.CH_2.CO_2H$, containing no asymmetrical carbon atom, and being inactive.—*Ber. Berl. Chem. Ges.*, ix, 215, Feb., 1876. G. F. B.

12. *On the Re-conversion of Paroxybenzoic acid into Salicylic acid.*—Neutral potassium salicylate, as Ost has shown, when heated to 210°–220°, splits up into potassium paraoxybenzoate, phenol, and carbon dioxide; while the sodium salt affords no paraoxybenzoate. Kupferberg has succeeded in effecting the inverse reaction and in converting the paraoxybenzoate again into salicylate. 39·5 grams sodium paraoxybenzoate, heated to 280° to 295° for six hours in a current of carbon dioxide gas, yielded 7 grams of salicylic acid; or 56 per cent of the acid present. Salicylic acid is converted into paraoxybenzoate by heating the neutral potassium salt to 220°; paraoxybenzoic acid is converted into salicylic by heating the sodium salt to 290°.—*J. pr. Ch.*, II, xiii, 103, Feb., 1876. G. F. B.

13. *On a new Hydro-oxy-benzoic Acid.*—In the hope of obtaining trimesinic acid—an acid containing three carboxyl groups—Emmerling and Oppenheim oxidized oxyuivitinic acid by means of potassium manganate. The product, precipitated by hydrochloric or sulphuric acid, is purified by crystallization from hot water. It appears in thin colorless needles, fusing at 274°·5, and giving a yellow precipitate with ferric chloride. Analysis gave it the formula $C_7H_8O_3$, the barium salt being $(C_7H_7O_3)_2Ba,(H_2O)_2$ and the silver salt $C_7H_7AgO_3$. Fusion with potash separates water and converts it into benzoic acid.

$$C_7H_8O_3=C_7H_6O_2+H_2O.$$

—*Ber. Berl. Chem. Ges.*, ix, 326, March, 1876. G. F. B.

14. *On Vicin, a Constituent of Vicia sativa.*—Some time ago, Ritthausen described a crystallized highly nitrogenous substance obtained from the seeds of the vetch. He now shows that it is a new body, and has the composition $C_8H_{16}N_3O_6$. He assigns to it the name vicin. A kilogram of seeds yielded 3·2 grams of vicin.—*Ber. Berl. Chem. Ges.*, ix, 301, March, 1876. G. F. B.

14. *Acoustic Attractions.*—M. Dvorak has examined the attractions and repulsions of small pendulums hung near sonorous bodies. A square of paper or a piece of cork is hung by a silken thread, and held near a wooden rod vibrating slowly. Varying the positions of the pendulum it is sometimes attracted and sometimes repelled. These motions seem to be due to the air-currents approaching or receding from the rod, and the motions of the cork served to determine approximately the directions. These results were verified by the motions of a flame and the indications of a very sensitive water manometer. The air thrust aside by the vibrating rod escapes laterally, repelling light bodies. This is replaced by air forming counter-currents toward the rod, producing the effect of attraction. When the amplitude of the vibrations is small, the rod acts like the prongs of a tuning fork, and attraction takes place in every direction.

In front of the opening of a tube of Kundt, is placed a second open tube, giving the same sound as the first, and suspended by two threads. Making the first tube resound loudly, the second tube is strongly repelled. The same effect is obtained if the second tube gives one of the harmonies of the first. Placing two tubes facing each other opposite the tube of Kundt and perpendicular to its axis, they tend to approach each other. With a very sensitive manometer it appears that in a column of air in a state of permanent vibration, the air at the nodes has an excess of pressure. This accounts for the heaping up of water in the loops of a tube of Kundt. It is explained by admitting that the amplitude of the vibrations cannot be neglected compared with their length. It follows that there ought to be a continuous motion of the air from a node to a loop. This might be proved by filling the resonant box of a tuning fork with the fumes of chloride of ammonium and seeing if they are thrown out when the fork is set in vibration.

If a bell is filled with water and a drop of oil allowed to fall on it, the circular film becomes quadrangular when the bell is sounded. The water-currents start from the nodes and accumulate at the loops. A disk of glass is attached to the end of a rod vibrating longitudinally. If a glass drop is hung opposite the disk it will be repelled at the center and attracted around the periphery. There are then, as with air, currents outward at the center, and counter currents inward along the edges.—*Journ. de Phys.*, v, 122.

E. C. P.

15. *Correlation of Forces.*—M. Grove describes a convenient apparatus for showing the relations between heat, electricity, and mechanical force. The arrangement is as follows:

Two of Clamond's thermo-electric generators are connected for quantity and put in communication with a gram machine, in such a way as to set this in motion. In the circuit is inserted a sort of electric lamp, in which a platinum wire, placed in the center of a small globe (which protects it from agitation of the air) can be raised to incandescence. The only difficulty of the experiment consists in so regulating the length and diameter of the platinum wire, that it may be raised to a red heat while the thermo-electric current retains sufficient intensity to drive the gram machine.

A circuit entirely metallic is thus obtained, with which the following transformations can be effected;

(1.) The gram machine being excluded from the circuit, a portion of the heat, transformed into electricity by the thermopile, reappears as heat in the wire.

(2.) The wire being excluded from the circuit and the machine introduced, a portion of the heat, transformed into electricity in the pile, reappears as work in the machine.

(3.) The wire and machine being included in the circuit, a part of the heat, transformed in the pile into electricity, produces heat in the wire and work in the motor. If we then stop the machine, the incandescence of the wire is increased. The machine being libera-

ted, on the other hand, starts, and the wire cools as its motion increases. The expenditure of heat needed to develop an increasing quantity of mechanical work is thus rendered sensible to the eye.

(4.) Turning the machine in the direction of the rotation produced by the current, a velocity may be reached such that the incandescence shall completely disappear.

(5.) Turning the machine in the opposite direction, there is considerable resistance, and the wire rapidly grows hotter, and is soon fused.

Thus, in the metallic circuit under consideration, the circulation of a given quantity of energy may appear exteriorly in the form of heat, or, as work. If, by an exterior force, we introduce into the circuit an additional quantity of work, the increase of the quantity of energy put in circulation is rendered visible by the incandescence of the wire; any communication outward from the circuit, of a certain quantity of energy which circulates in it, appears, on the other hand, in diminution, or even disappearance, of the incandescence.—*Journ. de Phys.*, iv, 359; *Nature*, xiii, 434. E. C. P.

15. *Change of Volume of Electric Conductors.*—Herr Exner has measured the change in length of a conductor through which an electric current is passing, by a method free from the error caused by the expansion due to the heat generated by the current. Two pieces of the same wire of nearly equal lengths were hung one over the other, and so connected with a battery that the current might be passed through either. The lower wire passed through a glass which might be filled with water if desired. The elongation was measured by resting the end of the wire on a lever carrying a mirror whose deflection was read by a telescope and scale. The current being passed successively through the two wires a different deflection was obtained in each case, but these were rendered equal by inserting an additional resistance in circuit with that wire whose elongation was greater. The tube was now filled with water so as to carry off the heat generated in the lower wire as rapidly as possible. It was found that the galvanic expansion was only 1·2 to 2·2 per cent of the heat expansion; and no connection was recognizable with the nature of the metal employed. If it be considered that these values, of course, can only by an upper limit, it will follow from the smallness of the effect obtained that there is no sufficient ground for the hypothesis of a special expansion power of the galvanic current. There can hardly be any doubt that the slight expansion which the water-enclosed wire still shows is simply and alone due to the heat remaining in it.—*Nature*, xiii, 452. E. C. P.

16. *Proper Motion of the Stars.*—P. Secchi points out a new source of error in the measurement of the proper motion of the stars by the displacement of the lines of the spectrum. The author tabulates a number of the observations made by Huggins, Vogel and himself, and those at Greenwich Observatory, and shows there is considerable contradiction in the results.

The question arises whether there may not be some systematic error in the manner of observing or in the instruments. Comparing the dark line F of Sirius with the hydrogen line Hβ of a Geissler tube, he got always the same result — a shortening of the Sirius line occurs (contrary to Huggins) when the telescope was carried along by the clock-work, and the assistant was at the seeker to keep it on a fixed point corresponding to the slit of the spectroscope; but if the clock-work stopped, or the assistant deranged the position of the star, the light line was displaced and came into coincidence with the star line. Dispensing with clock-work the line was found to be on one side or the other, according as the star was looked at on one side or the other of the axis of the telescope. A change was also noticed on turning the spectroscope 180° on its axis. No attempt is made to explain these phenomena, but they are pointed out as possible sources of illusion. — *Comptes Rendus*, lxxxiii, 761, 812; *Nature*, xiii, 480. E. C. P.

II. Geology and Mineralogy.

1. *Paleozoic fossils from a limestone associated with the Serpentine formation* (*Zone of the Pietre verdi*) *of Chaberton* (*Alpi Cozie*).—Prof. B. Gastaldi, in the Bulletin of the R. Comitato Geol. d'Italia for 1875, p. 346, has published a paper on discoveries made by G. Michelotti, a letter from whom is published in the paper. An accompanying geological section, by Michelotti, gives the stratification of the upper part of Mt. Chaberton: No. 1, the dolomitic limestone; 2, anthracitic sandstone of a red color, with black beds containing lamellar hematite, etc.; 3, quartzyte, with beds of gypsum; 4, talcose "calcischist," of a greenish color. Michelotti states that in an amphitheater under the summit of the mountain, bounded by lofty walls of dolomitic limestone, regularly stratified, presenting splendid examples of folding, he found in fragments of the limestone, among some detritus of serpentine, various limestone blocks that were fossiliferous. The fossils were not as well preserved as could be desired, owing apparently to incipient alteration, but they enabled him to distinguish the following genera: *Syringopora*, near *S. abdita*, (a fine species with the long branches one-sixth to one-third of an inch in diameter, and one-eighth to one-fourth of an inch apart, according to the figure); *Halysites;* a branching coral supposed to be a *Favosites;* a joint of a stem of an *Actinocrinus;* a shell of an Ostracoid, referred to "*Cythereis;*" and a sponge, *Lithospongia.* The species indicate that the limestone is probably of the age of the later Upper Silurian, or the earlier Devonian.

Prof. Gastaldi remarks that the limestone beds are superimposed directly on the serpentine, euphotide, and variolite of the region, in some places with a rather sudden transition from one to the other; but also that at other localities the more recent beds of the *pietre verdi* zone, that is, the "*Calcischist*" containing beds of

limestone which afford fossils, seem to pass into the *pietra verdi* by a gradual transition. He supposes, however, that the *pietra verdi* may still be pre-Paleozoic. Yet he offers no evidence to show that it is not merely older Paleozoic. He regards the question one requiring special study, and, in closing, expresses the hope that it may speedily be settled by new discoveries.

The limestone of Mt. Chaberton is stated to be probably equivalent with that of Montaldo Dora, of Lessola near Ivrea, of Rivara, and of Levone; it also occurs at Susa, at the Piccolo Moncenisio, at Seguret, along the French frontier between Frejus and Chaberton, at Balmas, at Rognosa, at Chinivert, and at other places.

The following number of the same Bulletin contains a paper by C. DE STEFANI, sustaining the ground that the serpentine beds of the Apuan Alps *overlie* the Middle and Lower Eocene; that those of several localities in Tuscany are between Cretaceous strata or Eocene; and that those of Elba, Gorgona, Gichio, Jano, and perhaps those of Montecristo and Cape Argentario, are older than the Lower Lias but newer than the Carboniferous.

2. *Eozoon Canadense not organic.*—This is the conclusion of Mr. Otto Hahn after geological and zoological investigations, an account of which is published in the Naturwissenchaftliche Jahreshefte for 1876 of Wurtemburg, and a translation in the Annals and Magazine of Natural History for April. He says, "By my investigation it is established that there is no gigantic foraminifer in serpentine limestone;" "that the most essential characters of the foraminifera, the chambers and the test are not there, but that we have to do with pure rock-formations such as occur every where in serpentine;" that "there is no rock which is so certainly the result of metamorphism, and can be derived from so many minerals, as serpentine;" that he has investigated an immense number of serpentines and always found that they are products of metamorphism." One of the masses of Eozoon which Mr. Hahn examined was from Canada, and bore Dr. Carpenter's label.

3. *Exploration of Lake Titicaca;* A. AGASSIZ and S. W. GARMAN, (Bull. Mus. Comp. Zool., iii, 274).—The Paleozoic fossils collected by these authors about Lake Titicaca are described by Mr. O. A. Derby. Nine are Carboniferous and all but one, *Euomphalus antiquus*, are represented by the same or closely allied species in the United States and Brazil. No Subcarboniferous fossils were met with; but Devonian were found close along side of the Carboniferous at the island of Coati two or three miles from the Lake. The Carboniferous formation extends in a general northwestern direction, and the beds are tilted, often at a high angle. According to Mr. Orrego the formation extends as far north as Callyoma; Prof. J. Orton found, in the same line, Carboniferous fossils at the headwaters of the Amazonas (Pichis R.) and states that Prof. Raimondi, of Lima, has traced the rocks to a height of 14,000 feet, on the Apurimac, between the Pichis and the Cuzco valley.

4. *Note "On the Youngest Huronian Rocks South of Lake Superior;"* by ROLAND IRVING.—In a paper with the above title published in the March number of this Journal, Mr. T. B. Brooks, by an accidental misquotation, makes me responsible for a rock composed of a strange medley of minerals. He says that I mention "these rocks as being coarsely crystalline aggregates 'chiefly of labradorite and orthoclase feldspar, hornblende and some variety of pyroxene.'" I wrote,* "Nearly all of them can, however, be included in two or three general kinds, labradorite, orthoclase felspar, hornblende and some variety of pyroxene seeming to be the chief ingredients." In this I meant to mention the main ingredients of the different kinds, not to say that all of these minerals occur in one rock. I am inclined, with my present knowledge, to follow Mr. Brooks in referring to the Huronian the belt of rocks in Northern Wisconsin, to which the above quotation alludes, as I followed him before in referring them to the Copper Series.† I cannot agree with him in designating the rocks as "granitoid," as, so far as my knowledge goes, they are chiefly rocks of a low degree of silication consisting mainly of labradorite and pyroxene. The general run of the rock in the country occupied by this belt west of Bad River is a dark colored coarsely crystalline mixture of the above minerals, accompanied by hypersthene, magnetite and mica as accessories, as ascertained recently by Mr. Chas. E. Wright from a microscopic examination made by him for me. The "granitoid" rocks which Mr. Brooks has seen occur as patches among these dark colored diabases and allied rocks. In the former only have I noticed orthoclase and hornblende.

University of Wisconsin, April 27th, 1876.

5. *Gigantic fossil bird from the Eocene of New Mexico;* Prof. COPE. (Proc. Acad. N. Sci. Philad., 1876.)—This bird was related both to the Cursores (Struthionidæ and Dinornis) and to Gastornis of the Paris basin. Its size was twice that of the ostrich. Prof. Cope names it *Diatryma gigantea.*

6. *Richmond Infusorial Stratum.*—Mr. Charles Stodder in a paper on the Richmond Infusorial stratum, first described by Professor W. B. Rogers in his Virginia Report of 1840, (this Journal, xlv, 313, 1843), states that Mr. R. B. Tolles examined the stratum as it is exposed in a ravine on the west side of Shockoe Hill, near Richmond, and obtained specimens at the depths, 5, 7½, 10, 11, and 14 feet below the top of the bank, and and also from the north side 40 feet below the top, from a bed which was apparently a continuation of the 14-feet bed, the hill being higher on the north side. The lower layer contains 50 to 80 per cent of organic forms, the uppermost about 20 per cent. The species below this top layer vary but little; while in that they are partly different in species, and the frustules are less broken.

* See paper "On the Age of the Copper-Bearing Rocks of Lake Superior, this Journal, July, 1874.

† Pumpelly and Brooks, this Journal. vol. iii, 1872.

The species of Diatoms peculiar to it are: *Coscinodiscus perforatus*, *Aulacodiscus crux*, *Eupodiscus Rogersii*, and *Mastagonia actinoptychus*. Mr. Stodder gives a list of the species afforded by the several beds.—*Proc. Boston Soc. Nat. Hist.*, xviii, 206, 1875.

7. *Carboniferous Articulates.*—Mr. S. H. Scudder has described (Canadian Naturalist, April, 1876) a fossil larve from a Carboniferous shale near Sydney, Cape Breton, which he refers to a genus near Libellula, and names provisionally *Libellula Carbonaria;* and also, accompanying it, part of a wing of a Cockroach, which he names *Blattina sepulta.*

Mr. Scudder has also published a supplement to his paper on Carboniferous Myriapods (noticed in this Journal, III, vi, 225) in the Memoirs of the Boston Society of Natural History for 1875, giving figures of the specimens there described.

Mr. H. Woodward has described a new fossil Scorpion, from the British Coal-measures, at Sandwell Park and Skegby Collieries, naming it *Eoscorpius Anglicus;* also a gigantic Orthopterous Insect, from Scotland, which he calls *Lithomantis carbonarius.*—*Q. J. Geol. Soc.*, xxxii, 57, 60, 1876.

8. *Note on the Uinta and Wahsatch Ranges: A Correction.*—In vol. III, chapter 7, of the reports of the United States Geological Exploration of the Fortieth Parallel, in mentioning the Wahsatch and Uinta ranges, I stated that the date of their uplift was at the close of the Jurassic period. The chapter was written in 1869, after a brief visit to the two ranges and before the final determinations of horizons and fossils were effected. In 1870–'71–'72 a more careful examination revealed the fact that the more important uplift of these two ranges occurred at the close of the Cretaceous, and not at the close of the Jurassic period. The error had arisen from the extremely close resemblance of certain conglomerates of the lower Eocene with those of the lowest horizon of the Cretaceous. In the Uinta range it was in reality the Eocene conglomerates, and not those of the lower Cretaceous, which we had observed resting unconformably upon the upper shales of the Jurassic. Continued delay in the publication of the geological volumes of our series induces me now to make this correction. In the case of the Uinta there is clearly no non-conformity, from the lowest exposures of the Carboniferous to the highest Cretaceous horizon, while the lowest Eocene rests upon the Cretaceous with distinct non-conformity.

In the Wahsatch the evidence is far more complicated. While the post-Cretaceous disturbance clearly had its profound effect on the range, there are also many facts which confirm our belief that the close of the Jurassic also marked a period of orographical activity, as it did in the Sierra Nevada. CLARENCE KING.

9. *The trilobite, Ceraurus pleurexanthemus, of Trenton Falls, New York.*—Mr. C. D. WALCOTT has given an account of the mode of occurrence of this species and of the characters of the under surface of the dorsal shell, in vol. xi of the Annals of the

Lyceum of Natural History of New York, pp. 155 and 159. He states that the specimens in some layers of the limestone are very numerous: 326 entire specimens were counted in a space measuring 30 feet by 40; and, of these, all but 8 lay with the back downward, the position which exuviæ of the concave form in Ceraurus would take. Their length varies from $\frac{3}{16}$ of an inch to 2 inches. The separated heads are found in immense numbers, and the surface of the rocks is sometimes nearly covered with them.

10. *Glacial phenomena in Jefferson Co., New York.*—According to T. G. B. Lloyd, (Q. J. Geol. Soc., xxxii, 76), the glacial scratches between Philadelphia on the southeast of Theresa and Redwood on the north, (distant ten miles), have a southwest direction, coinciding with the longer axis of most of the lakes between Theresa and Redwood, and with the general course of Indian River. The course is the same as that observed by Emmons near Watertown. Well characterized *roches moutonnées*, with their steepest side facing southwest, occur near Theresa. Mr. Lloyd also describes a pot-hole in the Laurentian granite which is 29 feet deep and 7 to 10 feet in diameter.

11. *Origin of the Porphyry of Marblehead, Mass.*—Mr. T. T. Bouvé, in the Proceedings of the Boston Society of Natural History for January 19, 1876 (xviii, 217), discusses the origin of the red porphyry and red felsyte rock of the vicinity of Marblehead, and proves it to be of metamorphic origin. The felsyte has long been known to contain disseminated grains or fragments of quartz.

He states that in 1862 he observed that the felsyte, near Hingham, was in part pebbly and slaty, and graduated into a conglomerate, and had evidently been derived from the alteration of the conglomerate. His observations since have confirmed this conclusion. [A fine series of specimens was exhibited, illustrating the transitions.]

Mr. Bouvé stated further that he was disposed to include among the rocks having the same origin some, at least, of the underlying syenytes. The succession of rocks as given by others, is—(1) conglomerate; (2) compact feldspar or felsyte, gradually passing into porphyry; (3) porphyry, gradually passing into a rock between porphyry and syenyte; (4) syenyte; and this relation of the beds Mr. Bouvé observes, is itself probable evidence that the causes that led to the changes in the higher portions of the series affected all, though in varying degrees.

The reading of Mr. Bouvé's paper was followed by remarks by Mr. Hyatt, sustaining the view that had been presented respecting the origin of the porphyry. Among his facts he stated that at one point on the ocean side of Marblehead Neck, the variegated conglomerate is altered to compact light-colored felsyte in one direction, and in another to a true deeply colored porphyry, containing distinct crystals of feldspar; and that the included pebble may sometimes be traced until it becomes, without any change of form, a mere spot in the light felsyte matrix, the interior last losing its original characteristics.

12. *Annual Report for* 1874 *of the U. S. Geological and Geographical Survey of the Territories;* F. V. HAYDEN, U. S. Geologist in charge. Conducted under the authority of the Secretary of the Interior. 8vo, with numerous illustrations (88 full paged) and maps. Washington, 1876.—During the year 1874, the explorations of the expedition, under the general charge of Dr. Hayden, were carried on in Colorado, with Denver as headquarters. In the introductory remarks—a letter to the Secretary of the Interior—Dr. Hayden states that the series of older metamorphic rocks, of probable Archæan age, have "alone afforded the precious metals and minerals of Colorado." The volume contains a Report by Dr. HAYDEN on the Lignitic series, the geology of the eastern base of the Front Range, glacial phenomena, and on the Elk Mountains (40 pages); a Report on the geology of the Northwestern portion of the Elk Range by W. H. HOLMES (14 pp.); Report on the features and geology of the valleys of the Eagle, Grand and Gunnison Rivers, and on the detailed features of the formations of the district by Dr. A. C. PEALE (106 pp.); Report on the Geology, etc., of the San Juan division by F. M. ENDLICH (62 pp.); valuable Reports by L. LESQUEREUX on the Tertiary flora of the Lignitic beds, and on the Cretaceous flora of North America, with descriptions of new species (94 pp. and eight plates); Report of W. H. JACKSON, on Ancient Ruins in Southwestern Colorado (13 pp.); besides also a short zoological report by E. INGERSOLL; Geographical and topographical Reports of HENRY GANNETT, S. B. LADD, A. D. WILSON, F. RHODA; also a Report on the superficial deposits of Nebraska, by S. AUGHEY.

No mention is made of Mr. James T. Gardner and his party, who had charge of the Topographical department of the Survey.

Dr. Hayden, in his remarks on the Lignitic series, sustains the views stated in a notice of a paper of his on p. 148 of this volume. He observes that the formations which have been recognized along the eastern front in Colorado above the Archæan are the Silurian, Carboniferous, Triassic (?), Jurassic, Cretaceous and Tertiary. The beds of the Lower Silurian occur along the Black Hills, Big Horn and Wind River Mountains, and near Colorado Springs and Cañon City, but none have been found by the survey for the 200 miles between Fort Laramie and Colorado Springs.

Dr. Peale's excellent report presents a large series of facts with reference to the various geological formations in his district from the Archæan to the Quaternary, and including the igneous rocks. On Eagle River, and between it and Grand Rivers, beds of sandstone and limestone variously colored, and in the upper parts gypsiferous, afforded the plants *Calamites Suckovii*, *C. gigas*, *Stigmaria ficoides;* and Lesquereux concludes, since *C. gigas* has not been found below the Permian, that the beds are probably *Permian.* From the lower part of the series, Dr. Hayden has reported species of *Productus*, *Spirifer*, and from the upper, an *Orbicula.* Dr. Peale calls the beds *Permo-Carboniferous.* Mr. Marvine observed the beds passing down into the Carboniferous.

The question as to the age of the Lignitic beds is well discussed by Dr. Peale; and in the course of this discussion a full tabular list is given of all papers on the subject hitherto published, their places of publication, and the views they present, the several regions of the beds being taken up in succession.

The conclusions are:

That the Lignitic beds of Coalville and Bear River are undoubtedly *Cretaceous:* whether the Evanston should be included is left doubtful.

That the Judith beds are *Cretaceous*, and have their equivalent along the eastern edge of the Mountains (Front Range) below the Lignitic or Fort Union group, and also in Wyoming, and are, either, part of No. 5 (Fox Hills Group) of the Cretaceous, or, a group to be called No. 6.

That the coal (which is partly anthracite) of Rock Creek, Slate Creek, Anthracite Creek and Ohio Creek, is probably all of Cretaceous age. The coal of some beds is excellent, two analyses giving 88·2 and 91·9 p. c. of carbon. The anthracitic character is owing to a trachytic eruption.

That the Fort Union group (at Fort Union, Fort Clark, and under the White River beds, on the North fork of the Platte River, above Fort Laramie and west of Wind R. Mts., also on Grand River, Nebraska and farther north) and the Bitter Creek series (including beds of Black Buttes, Hallville, Medicine Bow, Carbon, Point of Rocks, the Rock Spring series and Washakie Station) are, although both afford Dinosaurian remains, *Lower Eocene.*

That the Lignitic beds east of the mountains in Colorado are the equivalent of the Fort Union group of the Upper Missouri, and are *Eocene;* "also that the lower part of the group, at least at the locality 200 miles east of Greeley, is the equivalent of a part of the Lignitic strata of Wyoming." The Lignitic beds near Golden, Denver, Colorado Springs, Cañon City, Raton Hills, are placed in a table with those of the Fort Union group; but are not afterwards remarked upon.

13. *Age of Angiospermous plants referred to the Cretaceous.*— In my notice of a paper by DeCandolle, on pp. 447–449 of this volume, I remark that the "Cretaceous plants of the United States are the plants of beds which had previously been determined, through the animal fossils, to be Cretaceous." This statement needs, as I find, some modification. It is a fact that the plant-bearing beds of the Lower Cretaceous of New Jersey and the Rocky Mountain region have been referred to the Cretaceous for stratigraphical reasons; and those of New Jersey on this ground, long before the plants were found. But the *chief* evidence in favor of this reference in the Rocky Mountain region was, as I learn from Dr. F. V. Hayden, who has been prominent in collecting the facts, the *existence of Angiospermous leaves*, the animal fossils

having been found in the layers just above those containing the leaves instead of those below. Further we have to admit that the stratigraphical evidence is far from demonstrating in either region that the plant-bearing beds are not Upper Jurassic. DeCandolle's charge is hence not far from right, and should be set aside, if possible, by further observations. Looking over Dr. Hayden's Report for 1874 (noticed above) I find that the Lignitic of the Dakota group (Lowest Cretaceous) is stated by Dr. Peale to have been observed at the mouth of the Gunnison to be *underlaid* by beds which contain a Cretaceous *Scaphite*, and Mr. Peale also mentions that Dr. Newberry speaks of the Cretaceous *Gryphea Pitcheri* being associated with the lower Lignitic beds of the same period. These appear to be pertinent facts. But more are needed. J. D. D.

14. *Swiss Paleontological Society.*—This society was founded in 1874, upon the plan of the Paleontographical Society, for the purpose of publishing the paleontological works of its members, especially those concerning Switzerland, and also of continuing, in a slightly different form, Pictet's *Matériaux pour la Paléontologie Suisse.* The volume for 1875 has just been distributed. It includes the second part of a monograph of *Pholadomya*, with 14 plates, by C. Mœsch; descriptions of Jurassic fossils from Savoy, and remarks upon their vertical distribution, with 7 plates, by E. Favre; further contributions toward distinguishing the Horses of the Quaternary, with 3 plates, by E. Rütimeyer; description of a lower jaw of *Dinotherium Bavaricum*, with 1 plate, by Is. Bachmann; description of Tertiary Echinoderms of Switzerland, with 8 plates, by P. de Loriol. The volume for 1874 contained the first part of Mœsch's monograph of *Pholadomya*, with 26 plates, and a description of fossil plants from Sumatra, with 3 plates, by O. Heer. The society announces, as in preparation, several papers upon fossil Mollusks, Crinoids, Echinoids, Nummulites, Ammonites, Turtles, Stags, etc. The work deserves better support than it has yet received. Only six American names are upon the list of members. The annual subscription is 25 francs, payable in advance to Prof. Eugene Renevier, Lausanne, Canton de Vaud, Switzerland.

15. *Geological Survey of New Jersey.*—Annual Report of the State Geologist, Prof. G. H. Cook, for the year 1875. 42 pp. 8vo. Trenton, N. J., 1875.—This report is mainly economical in its facts. It is accompanied by a large map showing the triangulations of the U. S. Coast Survey, including the primary stations selected in 1875.

16. *Eocene Corals of Italy.*—The memoir of Prof. d'Archiardi, of Pisa, on the Eocene corals of Friuli, has been issued as a separate work. It contains 100 pages of text, in 8vo, (describing a large number of species,) and 16 beautiful lithographic plates. The deposits of Friuli, as described by Prof. Taramelli, are a marly limestone containing echinoderms, and, below this, beds of

different kinds containing the fossil corals. The species are more than 120 in number and many of them are published as new. They show that the Italian seas in Eocene time were within the limits of the coral-reef seas.

17. *Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen;* von P. Groth. 528 pp. 8vo. Leipzig, 1876.—Professor Groth of Strassbourg has done excellent service for the science of mineralogy by putting in the hands of students a clear and comprehensive work upon Physical Crystallography. He takes up first the general subject of wave-movements and the undulatory theory of light, and by a series of careful descriptions, aided by excellent illustrations, makes the whole subject very intelligible without the use of mathematical formulæ. The fundamental laws of light are then explained, and, as following from them, the various optical properties of crystallized minerals; the whole being treated in a thorough and comprehensive manner. The properties of crystals in their relation to heat, electricity, and magnetism, are also fully described. The second part of the work embraces a discussion of the forms of crystals, based especially upon the general laws of symmetry which characterize the different systems. The illustrations throughout the work are of a high degree of excellence: this is especially true of the colored plates at the end of the volume. A special chapter is devoted to the description of the various instruments employed in optical researches, and a considerable number of detailed examples are given. E. S. D.

III. Zoology.

1. *Recent Corals from Tilibiche, Peru, nearly 3000 feet above the sea-level.*—Professor A. Agassiz, in his recent South American tour, found a coral limestone at Tilibiche, 2,900 to 3,000 feet in elevation, about 20 miles in a straight line from the Pacific. The ravine where it occurs is about 450 feet below the general level of the nitrate basin of Peru. Two species of corals, modern in aspect, are described by L. F. Pourtalès, both new species, *Isophyllia duplicata*, and *Convexastræa ? Peruviana*, and besides these a Millepore was observed near *M. alcicornis*. Professor Agassiz concludes that the Pacific, within comparatively recent times, extended through gaps in the Coast Range and made an internal sea, which stood at a height of not less than 2,900 feet, and probably much above this, as the sea must have played an important part in the deposition of the salt and the nitrates of the nitrate beds; and consequently, that there has been an elevation since the formation of the coral reefs, of not less than 2,900 feet. The presence of other extensive saline basins at a height of 7,000 feet seem to make the submergence still greater. The existence of eight species of *Allorchestes* (Amphipod Crustaceans), a salt-water genus, in Lake

Titicaca, is stated to suggest the presence of the sea, at no very distant period, at a height of 12,500 feet.—*Bull. Comp. Zool.*, iii.

The facts have a special interest from the fact that there are now no coral reefs on the South American Coast south of Cape Blanco, near the equator, owing to the cold oceanic currents of the coast. The Coast Range would have been a protection against those currents in the era of the Tilibiche coral reefs.

2. *Caspian Sea.*—The zoology of the Caspian Sea has recently been studied by Mr. Oscar Grimm, with important results. He has found in this great half-salt lake 120 animal species, and states that the whole number existing there must exceed 150 species. His discoveries include 6 new species of fish, (a *Gobius* and five *Benthophili*), 20 species of Mollusks, (*Rissoa dimidiata*, *Hydrobia Caspia*, *H. spica*, *H. stagnalis* with two varieties, *Eulima conus*, *Neritina lituruta*, *Lithoglyphus Caspius*, *Bythinia Eichwaldi*, *Planorbis Eichwaldi*, sp. n., *Cardium edule* and var. *rusticum*, *C. Caspium*, *C. crassum*, *C. Trigonoides*, *Adacna vitrea*, *A. edentula*, *A. plicata*, *A. læviuscula*, *Dreissena polymorpha*, *D. Caspia*, *D. rostriformis*, and some other terrestrial and fluviatile Mollusca), a Bryozoan (*Bowerbankia densa* Farre, in which the colonial nervous system may be admirably seen), and about 35 species of Crustacea, among which we find the family Gammaridæ in particular represented by colossal forms and *Idothea entomon* in considerable quantities. Then there are 20 species of worms (*Sabellides octocirrata*), numerous Turbellaria, two sponges (*Reniera flava*, sp. n., or perhaps a variety of *R. alba* O. Schm., and another *Reniera* in the larval state), and, lastly, 13 Protozoa, among which are 6 new species.

The most interesting gatherings were made at 108 fathoms. At one haul the dredge brought up 350 specimens of Gammarids, belonging to 4 or 5 species, 150 specimens of *Idotea entomon*, 50 *Mysids* of colossal dimensions, 6 fishes, a multitude of large specimens of *Hydrobia Caspia*, *Dreissena rostriformis*, and enough more of zoological specimens to make four times this number.

Among the author's conclusions are the following. These species common to different seas, show the affinities of the Caspian Sea to the Aral Lake, the Black Sea, and the Arctic Ocean; but the affinities with the glacial sea seem to be more recent than those with the Black Sea; for in the latter certain species, such as the seals, *Coregonus leucichthys*, and others which are common to the Caspian and glacial seas, are wanting. We may suppose that in the Tertiary epoch there existed in Europe and in the neighboring parts of Asia a vast closed basin of fresh water. By an upheaval of the crust of the earth, due to the action of internal forces which still make themselves felt energetically in the region of the Caspian, this was separated into some smaller basins, which are the existing Black Sea and the Aralo-Caspian basin. The latter in its turn was afterward divided, just as we still see, into two small salt lakes separate from the Caspian. At the same time the

water of the glacial sea penetrated into the basin of the Caspian, which still had a slight connexion with the Black Sea, so that only a small number of animals could arrive there from the glacial sea. Hence we find that the primitive forms of the Caspian are fresh-water animals (*e. g. Dreissena polymorpha*), and then that the emigrants from the glacial sea which reached it are marine animals for the most part inhabiting great depths. Hence, also, we recognize that the Caspian in its fauna presents more affinities with the glacial than with the Black Sea, which, again, has become richer in animals under the influence of the Mediterranean.

The Caspian has not only received species from the glacial sea, but has also furnished it with some—as, for example, a species of sturgeon, which seems to be *Acipenser ruthenus*, and lives in the rivers of Siberia. I regard the Sturgeons as belonging to the ancient Aralo-Caspian basin, and as having emigrated, as has been said, into the glacial sea, and perhaps even to America, where, as is well known, the nearest relatives of the *Scaphirhynchi* of the Aral exist. On the other hand we may presume that the place of origin of the Acipenseridæ was the Indian Ocean, and that they were derived from the Selachia, with which, especially when young, they have many points in common (*e. g.* their teeth).—*Zeitschr. wiss. Zool.*, xxv, 322, 1875, condensed from *Ann. Mag. Nat. Hist.*, IV, xvii, 176, Feb. 1876.

IV. Astronomy.

1. *Il passaggio di Venere sul Sole, osservato a Muddapur nel Bengala*; Relazione di P. Tacchini. Palermo, 1875.—The party of observers under P. Tacchini were provided with five telescopes two of which had spectroscopes. In this volume we have the results of their observations. P. Tacchini concludes, that the spectroscope can be employed to advantage in transits; that the solar diameter is smaller in the spectroscope than in an ordinary telescope; that the atmosphere of Venus so appears in the spectroscope as to show that it has a large quantity of vapor like the earth's atmosphere.

2. *Planets recently discovered.*—In the August number of the Journal for 1875, p. 158, was given a table of the recently discovered small planets. We here continue it, repeating some of the planets whose elements were then not well determined. In that table the names Siwa and Polana were interchanged, also the value of φ for Aethra should have been 22° instead of 2°. The elements below so far as (147) are obtained from the Berlin Astronomische Jahrbuch for 1878.

The name of (139), the planet discovered by Prof. Watson while at Peking, is Jue-wa, written in Chinese by two characters, but in western languages to be written without a hyphen, as in the table.

PLANETS RECENTLY DISCOVERED.

No.	Name.	Time of Discovery.	Discoverer.	Mean dist.	Angle of Eccent.	Incl.	Long. of node.	Long. per.
					° ′	° ′	° ′	° ′
136	Austria,	Mar. 18, 1874.	Palisa.	2·2870	4 52	9 33	186 10	316 32
137	Meliboea,	Apr. 21, "	Palisa.	3·1334	12 2	13 46	204 18	310 20
138	Tolosa,	May 19, "	Perrotin.	2·4437	9 6	3 14	54 55	311 23
139	Juewa,	Oct. 10, "	Watson.	2·8140	2 57	8 19	358 37	115 32
140	Siwa,	Oct. 13, "	Palisa.	2·7316	12 29	3 12	107 2	300 33
141	Lumen,	Jan. 13, 1875.	Paul Henry.	2·7095	12 54	11 33	319 3	22 38
142	Polana,	Jan. 28, "	Palisa.	2·3872	3	2 18	292 36	227 23
143	Adria,	Feb. 23, "	Palisa.	2·7525	2 49	11 32	333 45	223 20
144	Vibilia,	June 3, "	Peters.	2·6501	13 29	4 52	76 50	8 21
145	Adeona,	June 3, "	Peters.	2·6939	12 17	14 24	77 43	118 8
146	Lucina,	June 8, "	Borelly.	2·7077	3 51	12 42	84 22	237 43
147	Protogeneia	July 10, "	Schulhof.	3·1254	1 42	1 57	252 29	84 43
148	Gallia,	Aug. 7, "	Pros. Henry.	2·7687	10 44	25 18	145 8	36 13
149		Sept. 21, "	Perrotin.					
150		Oct. 18, "	Watson.	2·9807	7 30	2 9	207 33	352 45
151	Abundantia	Nov. 1, "	Palisa.	2·5841	5 44	7 52	40 2	215 57
152	Atala,	Nov. 2, "	Paul Henry.	3·1320	4 43	12 10	41 29	80 0
153	Hilda,	Nov. 2, "	Palisa.	3·9504	9 23	7 51	228 20	284 42
154	Bertha,	Nov. 4, "	Pros. Henry.	3·2285	5 45	20 49	37 36	168 41
155		Nov. 8, "	Palisa.					
156	Xantippe,	Nov. 22, "	Palisa.	3·0375	15 17	7 29	246 11	155 57
157	Dejanira,	Dec. 1, "	Borelly.	2·5857	12 42	11 50	62 25	109 12
158	Koronis,	Jan. 4, 1876.	Knorre.	2·9901	16 59	1 23	282 49	355 10
159	Aemilia,	Jan. 26, "	Paul Henry.					
160	Una,	Feb. 20, "	Peters.	2·7334	3 28	3 51	9 18	56 49
161		Apr. 16, "	Watson.					
162		Apr. 21, "	Pros. Henry.					
163		Apr. 26, "	Perrotin.					

H. A. N.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Atti della Reale Accademia dei Lincei.* Serie 2, vols. 1, 2, 3. 4to, 1873–1876. Roma, 1875, 1876.—The "Accademia dei Lincei" held its first meeting near the beginning of the seventeenth century, and hence it is the oldest of existing scientific academies.* It has had, however, an intermittent existence, owing to the stifling conditions about it.

Founded by Federico Cesi, of the Roman nobility, in 1603, avowedly to promote the progress of truth, its members, and especially their leader, encountered almost immediate persecution; and in 1606 they were forced to suspend their sessions in order to escape greater evils. The Academy was at work again in 1609, and soon after, Galileo (then 45 years old), Baptista Porta and Colonna were among its members. The Academy adopted as its insignia the figure of a lynx—the piercing sight attributed from

* It was preceded in Italy, by the Academia Secretorum Naturæ, which was established by Baptista Porta, in 1560, and suppressed after a few years of existence by Pope Paul III.

ancient time to the lynx making it a fit emblem of the searching spirit of Science, of which Galileo was already an illustrious exponent. The members were "Lincei." They required that a candidate for membership should not be younger than 22 years or older than 30; and he must be devoted to the sciences of experiment or observation. Discussions in jurisprudence, modern history, theology, politics and poetry were excluded, because not properly within their range. The Academy had, in part, in conformity to the spirit of the place and times, the form of a religious order; for St. John the Evangelist was recognized as its protector, and the members were required to recite daily "l'officio della Beata Vergine." This, however, was not enough to save the "Lincei" from suspicion.

In 1630, Federico Cesi, the founder and patron of the Academy, died, to the grief and great loss of its members. The Academy had already come into disfavor, because Federico in 1625 had denied that the sky was solid, and Galileo had asserted that the earth moved; and, soon after Federico's decease, its sessions were for the *second* time, suspended. Some private meetings were occasionally held, under the protection of Cardinal Barberini, nephew of the pope, Urban VIII, at the house of Cassiano del Pozzo, where there was a rich museum. But in 1651, on the death of this Cardinal, the suspension became complete, and the Academy was for the second time dead; and so it remained for nearly a century.

Its revivification—the *second*—did not take place until 1740, when the learned and liberal Pope Benedict XIV, Lambertini, reinstated it and gave it the name of the "Accademia de' nuovi Lincei." But in 1758, on the death of this pope, it became for the *third* time extinct.

In 1795, a society of young men which had held meetings for scientific purposes since 1786 at the "Collegeis Umbro-Fuccioli" and which embraced among its members Feliciano Scarpellini, took the form of an academy, called the "Accademia Umbro-Fuccioli," which was in effect a revival—the *third*—of the old Academy. Owing to the political disturbances of 1801, the Academy was again suppressed. But in July, Pius VII, a patron of science and art, succeeded to the papal chair, and the meetings were resumed, Scarpellini having the full confidence and support of the pope. This was the *fourth* return to active life. It took at first the title of "Accademia Gaetani;" but in 1802 it adopted that of "Accademia de' nuovi Lincei," and in 1804, returned to the original name, dropping the *nuovi*.

The Academy continued in activity for forty years, sustained largely through the influence and labors of Scarpellini. With Scarpellini's death, in 1840, it became once more defunct, having been closed by Gregory XVI, against earnest solicitations. This pope finally gone, Pius IX succeeded; and being eminently liberal in his views when he took the pontificate, the Academy, a year

afterward, in 1847, was reëstablished for the *fifth* time, the Pope giving it the modified title "Accademia Pontificia de' nuovi Lincei."*

Finally, Rome having emerged from the dynasty of the popes, and become the Capitol of United Italy, under Victor Emmanuel, an extraordinary session was held in January, 1874, for the revision of the constitution. Among the changes, there was, first, the restoration of the original name "Accademia dei Lincei" with the addition of the prefix "Reale," recognizing the new government under which it existed. Next, the Academy was divided into two sections; one, of Physical, Mathematical and Natural Science, and the other of Moral, Historical and Philological Science; the former to consist of *forty* National Associates, *ten* Foreign Associates, and *sixty* Correspondents; and the latter of the same, excepting that the number of National Associates was made *thirty*. Eight foreign associates of the first section have been since elected; three residing in Great Britain, three in Germany, one in France, and one in the United States.

Of the *Atti* of the Academy, a second series was commenced in 1873, and three volumes have been published; vol. I. for 1873–1874; II. for 1874–1875, and III. for 1875–1876. They contain papers on Mathematical or Mathematico-physical subjects, by Volpicelli, Bataglini, Betti, Dini, Conti, Favero, Ascoli, Valentino, Cremona, Menabrea, Tonelli; in Solar Astronomy and Spectroscopy, by Respighi and Volpicelli; in Electricity by Govi, Ricco, and Volpicelli; in Chemistry by Cannizaro and Paternò; in Zoology, by Cadet, Maggiorani, Boll, Colasanti, De Sanctis, Moriggia, and Todaro, (the paper of the last an elaborate discussion of the anatomy of the Salpa with 10 4to plates; in Paleontology by Gastaldi, Capellini, Meneghini and G. Ponzi; on Volcanoes of Lazio, by G. Ponzi; on some Fungi Uredinei, by C. Bagnis Calor; in Meteorology, at the observatory of Campidoglio, by L. Respighi, and on the climate of Rome, by R. Paveto; Archæological discoveries about Rome by R. Canevari and others. Many of the articles are illustrated by plates.

Signor Cav. QUINTINO SELLA is now President of the Academy.

2. *Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains;* being the Seventh Annual Report of ROSSITER W. RAYMOND, U. S. Commissioner of Mining Statistics. 540 pp. 8vo. Washington, 1875.—This volume brings the subject down to the close of the year 1874. The condition of mining industry in California, Nevada, Idaho, Oregon, Montana, Utah, Colorado and Arizona, is given in about 400 pages, forming Part I, full of interesting details and accurate information gleaned with care from many sources, and states with great condensation often in tabular form, and arranged for easy reference. Part II is devoted to metallurgical processes—its Progress in the west

* The preceding historical facts are taken from an address to the Academy delivered in March, 1848, by Volpicelli, on the occasion of this last reinstatement. Only two preliminary meetings had been held in 1847.

during 1874; the distillation of zinc-silver alloy; silver-lead smelting at the Winnamuck Smelting Works; the Germania Refining and desilverization works, Utah; the construction and operation of a slag hearth; the Rocky Mountain Coal and Coke, condensed from a paper by Mr. Blodgett Britton; separation of gray copper ore from barytes; the Patchen process. Part III. treats of the geology of the Sierra Nevada in its relation to vein mining, by Amos Bowman, and his detailed observations will be read with profit by all who are interested in the genesis of veins however they may differ from some of the theoretical views of the author. This is followed by a history of the relative values of gold and silver, by R. W. Raymond, and another on improvements in mining and milling machinery in the Pacific States, by William P. Blake, with a description of the remarkable Silver Mill of the Consolidated Virginia on the "Big Bonanza" of the Comstock Lode in Nevada, and miscellaneous statistics.

We regret to state that unless some new action is had on the part of the General Government this is the last of the valuable series of Reports on the mineral resources of the United States which will appear.

3. *The National Academy of Sciences* held its regular annual meeting on April 18 to 21, at Washington City. The following are the titles of the papers read:

On the precise determination of the number of vibrations of tuning-forks, and on the effect of temperature and of amplitude of vibration on the vibratory periods of forks; by A. M. Mayer.

On a method of exploring the acoustic condition of the atmosphere, leading to the invention of an instrument for determining the direction of a source of sound; by A. M. Mayer.

On the sensations produced by concurrent sounds, and by sounds quickly succeeding one another; by A. M. Mayer.

On the theory of simultaneous ignition of many mines; by H. L. Abbot.

On Maxima and Minima in Algebra, by the late Gen'l D. P. Woodbury, with a biographical notice of the author; by J. G. Barnard.

The Character of the Eocene Fauna of New Mexico; by E. D. Cope.

Contributions to Meteorology; by E. Loomis.

A conjectural restoration of a pueblo of the Mound Builders; by L. H. Morgan.

The Geological evidence on the question of the cause of the cold of the Ice Period; by J. S. Newberry.

On the history of the Problem of the Tangencies; by B. Alvord.

On the theory of Magic Squares; by F. A. P. Barnard.

On the progress of a Magnetic Survey of the United States, at the charge of the Bache Fund of the Academy; by J. E. Hilgard.

Results of Experiments on Contact-resistance; by Wm. A. Norton.

On the imperfections of the present system of Chemical Nomenclature; by R. E. Rogers.

The Age of Mountains as determined by degradation; by J. W. Powell.

Biographical Memoir of Joseph Winlock, late Director of the Harvard Observatory, Member of the Academy; by Joseph Lovering.

On the Geological and Physical structure of the Black Hills; by Henry Newton.

4. *Memoir of Caroline Herschel*, by Mrs. JOHN HERSCHEL, with portraits. New York: D. Appleton & Co. 1876. 12mo, pp. 355.—The scientific life of Caroline Herschel as an observer and investigator in astronomy closed in 1822 with the death of her illustrious brother, William Herschel, with whom she was so

closely identified as to make the two lives almost one. She was already 72 years of age when she returned to Hanover, as she then believed soon to die. Her memoir is intensely individual. During her twenty-six years of exile in Hanover (1822 to 1848) from all those most loved in England, she maintained an active correspondence with her nephew, Sir John F. W. Herschel and his wife, and exchanged frequent letters with most of the eminent astronomers of the time in Europe. These letters, as well as parts of her diary and personal recollections, are excellent reading. We find in them much to compensate us for the want of productiveness, which Miss Herschel constantly laments as the great mistake of her life in not continuing in England; for if she had remained there this correspondence, so full of vitality and varied interest, would not have existed. While she was "minding the heavens" with her beloved "Sweeper," as of old, she would have found no time to record her recollections of her fifty years activity in her brother's service, to honor whom she was so willing to obscure her own real merits. But she will not be forgotten while scientific literature endures. We are led to hope that from the materials accumulated by her assiduity and other sources in the possession of the family of Sir John Herschel, we may yet have a satisfactory biography of Sir William Herschel—a work still wanting. B. S.

5. *The depth of the Pacific, and the nature of its bed.*—We take the following facts from a recent report by Prof. Wyville Thomson.

Between Hawaii and Tahiti, the depth, with one exception of 1,525 fathoms, ranged between 2,000 and 3,000 fathoms and has a mean of 2,600; the bottom, except near the islands, mainly red clay, with much oxide of manganese in small concretions, and many foraminifers; and over two patches, there were siliceous shells of Radolarians, making a "Radolarian ooze." The fauna of the bottom was very meager.

Between Tahiti and Valparaiso (reached on the 19th of October), 5,000 miles in distance, the course taken was southward to latitude 40° S., and then on that parallel to Valparaiso. The mean depth was 2,139 fathoms; the bottom was of red clay with nodules of manganese, with Globigerina ooze in the shallower parts. Life was very sparse, except between Juan Vernandez and Valparaiso, where, although the depth was 2,225 fathoms, it was abundant; the bottom was a bluish mud with very little manganese.

Notices of the following works are deferred to another number.

Reliquiæ Aquitanicæ, Part xvii, the closing part of the work. Williams & Norgate, London.

Geological Survey of Pennsylvania. Historical sketch of Geological explorations and other States, by J. P. Lesley. pp. 200 and xxvi, 8vo.

Mines and Mineral Statistics of N. S. Wales, 1875. 246 pp. with maps and sections.

Revue de Géologie pour les Années, 1873 et 1874, par M. Delesse et M. de Lapparent. Paris, 1876.

Geology for Students and General Readers. Part I, Physical Geography, by A. H. Green, M.A., F.G.S. 552 pp. 8vo. London. (Daldy, Isbister & Co.)

Second Annual Report of the Geological and Agricultural Survey of Texas, by S. B. Buckley, A.M., Ph.D., State Geologist. 96 pp. 8vo. Houston, Texas, 1876.

APPENDIX.

ART. LXVII.—*Notice of a new Sub-order of Pterosauria;* by Professor O. C. MARSH.

THE first Pterodactyle discovered in this country was found by the writer, in 1870, in the Upper Cretaceous of Kansas; and during the next year two other species were obtained in the same region.* These three species were referred provisionally by the writer to the genus *Pterodactylus* of Cuvier, with which the remains then described essentially agreed. An examination of the large series of specimens of this order now in the Yale Museum, shows, however, that some of these fossils possess characters widely different from all forms known in the old world, and indicate a new and highly interesting type. The distinctive feature in this group is the *absence of teeth*, and hence the order may be called *Pteranodontia*, and the family *Pteranodontidæ*, from the typical genus described below.

Pteranodon, gen. nov.

This genus is readily distinguished from any Pterodactyles hitherto described by the cranial characters, which are well shown in a nearly perfect skull, and portions of others, in the Yale Museum. The cranium preserved is very large, and the facial portion greatly elongated. There is a high sagittal crest, which projects backward some distance beyond the occipital condyle. The latter is directed backward, and somewhat downward. The quadrate is long, and inclined well forward. The orbits are large, as are also the antorbital and nasal apertures. The maxillary bones are closely coossified with the premaxillary, and the whole forms a long, slender beak, which, in the specimens examined, tapers gradually to the pointed apex. There are no teeth, or sockets for teeth, in any part of the upper jaws, and the premaxillary shows some indications of having been encased in a horny covering. The lower jaws, also, are long and pointed in front, and entirely edentulous. The rami are closely united by a symphysis which extends from the apex to beyond the posterior extremity of the dentary bone, thus resembling the mandible of *Rhynchops* and some other birds. In several other respects, the jaws in this genus are more like those of birds than of any known reptiles.

The vertebræ in the present genus are similar to those in European Pterosaurians, and the altas and axis are united.

* This Journal, vol. i, p. 472, 1871; vol. iii, pp. 241 and 374, 1872.

There are four phalanges in the wing finger, and the metacarpal that supports it is longer than one half the ante-brachium. In one specimen, which probably belongs to this genus, there are four slender bones, apparently all metacarpals, which are pointed above, and do not reach the carpus. Another specimen, which is described below, and probably belongs to this genus, has five vertebræ in the sacrum.

The nearly complete skull mentioned above may be regarded as the type of the genus *Pteranodon*. Its principal measurements are as follows:

Length from occipital crest to end of premaxillary about 30 inches, or	760· mm.
Transverse diameter of occipital condyle,	8·4
Distance from occipital condyle to distal end of quadrate,	105·
Length of lower jaw about 23 inches, or	584·
Greatest depth,	62·2
Depth at articulation for quadrate,	23·2

The species represented by this specimen is well marked, and may be called *Pteranodon longiceps*. It is somewhat larger than *P. occidentalis* Marsh, which apparently has more slender jaws. The Yale collection contains portions of a skull indicating a much larger species, which is probably *P. ingens* Marsh. If this skull was of the same proportions as that just described, its length would be no less than four feet!

One of the smallest American species yet found is represented in the Yale Museum by several bones of the wing, a number of vertebræ, and the nearly complete pelvis. The wing-bones preserved are elongated, and very slender. The pelvis is unusually small, and there are five vetebræ in the sacrum. The last of the series indicates that the tail was short. The following are the principal dimensions of this specimen:

Length of ulna,	187· mm.
Length of metacarpal of wing finger,	300·
Antero-posterior diameter of outer condyle at distal end,	15·
Transverse diameter of shaft, above condyles,	13.
Length of first phalanx of wing finger,	347.
Extent of five vertebræ of sacrum,	57.

This species, which may be called *Pteranodon gracilis*, was about two-thirds the size of *P. velox* Marsh. It probably measured about ten feet between the tips of the expanded wings.

All the specimens here mentioned are from the Upper Cretaceous of Western Kansas. It is an interesting fact that the localities and geological horizon of these specialized, toothless, Pterodactyles are precisely the same as those of the *Odontornithes*, or birds with teeth, and the two doubtless lived together in the same region.

Yale College, New Haven, May 15, 1876.

Pteranodon comptus, sp. nov.

The smallest Pterodactyle known from American strata is indicated by portions of three skeletons in the Yale Museum. Among these remains are two distal ends of the characteristic metacarpal of the wing finger, other portions of the wing bones, and two sacral vertebræ. The large metacarpal is very slender, and elongated, and its outer distal condyle has its superior margin elevated above the shaft, and terminated proximally in a point. The ulna is comparatively large, and the proximal carpal has an oval air cavity on its radial side. The sacral vertebræ have their centra short, and medially constricted.

The principal measurements of the remains of this species are as follows:

Greatest diameter of ulna at distal end,	15· mm.
Transverse diameter of proximal carpal,	17·
Antero-posterior diameter of outer distal condyle of wing metacarpal,	12·8
Longitudinal extent of condyle,	11·6
Transverse diameter of shaft above condyle,	11·5
Length of medial sacral vertebra,	9·0
Transverse diameter of centrum,	8·4

The above specimens are all from the Upper Cretaceous of Western Kansas.

Yale College, May 22, 1876.

ART. LXVIII.—*Notice of new Odontornithes*; by Professor O. C. MARSH.

AMONG the remains of Cretaceous Birds in the Yale Museum, are specimens which indicate two undescribed species of special interest. Both were of gigantic size, and clearly belong to the *Hesperornithidæ*, although quite distinct from *Hesperornis regalis* Marsh, the type of the group.* The more important characters of each, so far as now known, are given in the following description:

Lestornis crassipes, gen. et sp. nov.

The present genus is very nearly related to *Hesperornis*, but the sternum has five pits on each side for the attachment of ribs, and essentially no posterior emarginations. The tarso-metatarsal bones present a distinctive feature which may prove of generic value. On the inner side of the upper half of each, there is a large tuberosity, somewhat similar to the ossified

* This Journal, vol. iii, p. 360, 1872, and vol. x, p. 403, 1875.

support of a rudimentary spur. The teeth and the vertebræ in this genus resemble closely those of *Hesperornis*.

The present species is based upon the greater part of a skeleton, including portions of the skull. These remains indicate a huge swimming bird, fully six feet in length, from the apex of the bill to the end of the toes, or somewhat larger than *Hesperornis regalis*. The femur and the tibia resemble those in some modern diving birds, but the toes are shorter and stouter. The large rugosity on the metatarsal bone is a striking character, which may possibly be an indication of sex. The sutures uniting the three metatarsals are well marked.

The principal dimensions of this specimen are as follows:

	mm.
Length of sternum,	197·
Width in front,	162·
Extent of five articulations for ribs,	54·
Length of femur,	103·
Transverse diameter of distal end,	51·
Transverse diameter of tibia at distal end,	33·
Length of tarso-metatarsal,	135·
Transverse diameter of proximal end,	35·5
Transverse diameter through protuberance,	30·5
Length of first phalanx of fourth toe,	39·5

The known remains of this species are from the Upper Cretaceous deposits of Western Kansas.

Hesperornis gracilis, sp. nov.

A second species of *Hesperornis*, somewhat smaller than *H. regalis*, and of more slender proportions, is indicated by a few remains in the Yale collection. The most characteristic of these specimens is a left tarso-metatarsal, which in general form is very similar to the corresponding bone in *H. regalis*, but is much less robust. The following are its principal measurements:—

	mm.
Length (approximate) of tarso-metatarsal,	130·
Transverse diameter of proximal end,	29·
Antero-posterior diameter,	17·
Distance from proximal end to articulation for hallux,	78·
Transverse diameter of shaft at articulation for hallux,	15·1
Antero-posterior diameter,	18·
Antero-posterior diameter of distal condyle of third metatarsal,	14·
Transverse diameter,	7·

This species, also, is from the Upper Cretaceous of Western Kansas.

Yale College, New Haven, May 18, 1876.

Ichthyornis victor, sp. nov.

In addition to the remains described above, the Yale Museum contains a number of specimens which indicate a new species, apparently, of the genus *Ichthyornis*. The best preserved of these fossils consist of characteristic portions of the humerus, coracoid and scapula, all parts of one skeleton. They pertain to a bird somewhat larger than a pigeon, and about one-third larger than *Ichthyornis dispar* Marsh, the type of the order *Odontotormæ*.* The humerus has the radial crest greatly expanded, indicating strong power of flight. The radial condyle of the distal end is larger than that for the ulna. The coracoid is stout, and at its scapular articulation has a nearly round, deep pit, into which was inserted a corresponding tubercle of the scapula, forming a strong support for the humerus. Above this tubercle, the scapula has an anterior angle, sharp and pointed.

The remains preserved of this species have the following dimensions:—

Greatest diameter of distal end of humerus,	12·5 mm.
Longitudinal extent of radial condyle,	6·
Diameter of shaft just above condyle,	10·
Greatest diameter of coracoid at articulation with scapula,	6·5
Diameter of articular pit,	3·
Extent of coracoid above top of pit,	8·
Vertical diameter of scapula at articulation,	8·
Transverse diameter,	3·

The known remains of this species are from the same region and geological horizon as those above described.

Yale College, May 22, 1876.

* American Naturalist, Vol. IX, p. 630, Dec., 1875. This name was substituted for *Ichthyornithes*, which proved to be preoccupied.

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